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STATUE OF SIR WILLIAM FAIRBAIRN, AT MANCHESTER.

THE

YEAR-BOOK OF FACTS

IN

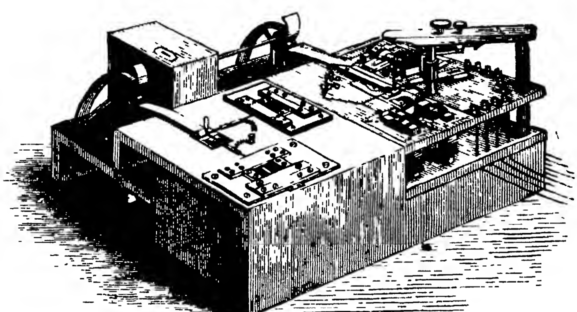
SCIENCE AND THE USEFUL ARTS

FOR

1879.

BY

JAMES MASON.



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PREFACE.

THE usefulness of the YEAR-BOOK OF FACTS is sufficiently proved by its long and successful career, and little need be said by way of introducing the volume for 1879. That volume—in harmony with the plan of our recent volumes—covers the period extending from the 15th of October, 1878, to the 15th of October of the current year. It will be found fully as interesting as any of its predecessors; on the whole, perhaps, more so, for science advances with more rapid strides every day, and we find ourselves drawing nearer and nearer a future which, so far as human knowledge is concerned, will be a true golden age.

In a work of this kind absolute accuracy is of course unattainable, but the compiler has done his best to guard against errors. He has drawn his information from all possible sources, and has to acknowledge obligations to more periodicals than can well be enumerated. It will perhaps be enough to name the *Times*, *Athenæum*, *Academy*, *Nature*, *Scientific American*, *Photographic News*, *Lancet*, *English Mechanic*. *Illustrated London News*, *Graphic*, and *Chambers's Journal*. To these he has been most largely indebted.

There is a real romance in science, and the facts recorded in the following pages exhibit enthusiasm in research and a self-sacrificing love for truth unequalled in any previous age. There is little doubt that a Year-Book of Facts is, if looked at in the proper light, quite as interesting as a whole library of fiction.

WARWICK HOUSE, SALISBURY SQUARE,
15th December 1879.

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THE

YEAR-BOOK OF FACTS.

I.—THE HUMAN RACE.

Anthropometrical Measurements.—The department of Anthropometry, of so much importance to the science of anthropology, has recently been carried to great perfection, and its method extensively applied. Very curious and interesting results have thus been obtained; and some of the most interesting of these have been recently published by Dr. A. Weisbach, chief physician to the Austro-Hungarian Hospital in Constantinople, who, Dr. von Scherzer tells us, has probably taken more measurements of living men than any other anthropologist.

Dr. Weisbach's measurements refer to 19 different peoples and more than 200 individuals from the most various parts of the earth. The most interesting of these measurements refer to the pulse, the length of the body, the circumference of the head, the height and length of the nose, as well as the comparison of the length of the arm and leg bones with each other. Thus, for example, the number of pulse-beats per minute varies within wide limits: the Congo Negroes (62), and next to them the Hottentots and Roumanians (64), have the slowest pulses. Then follow the Zingani (69), Magyars and Caffres (70), North Sclaves (72), and Siamese (74), Sundanese and Sandwich Islanders (78), Jews, Javanese, and Bugis (77), Amboinese and Japanese (78), and lastly the Chinese (79). The quickest pulses belong to the Tagals (80), the Madurese and Nikobars (84).

As to height, the smallest among the peoples measured are the Hottentots (1,286 millimètres); this is far behind any other people, as the next, the Tagals, are 1,562. Then follow the Japanese (1,569), Amboinese (1,594), Jews (1,599), Zingani (1,609), Australians (1,617), Siamese (1,622), Madurese (1,628), South Chinese (1,630), Nikobars (1,631), Roumanians (1,643), Sundanese (1,646), Javanese (1,657), Magyars (1,658), Bugis (1,661), North Sclaves (1,671), North Chinese (1,675), and Congo Negroes (1,676). The longest measurements, however, are found among the Sandwich Islanders and Kanaks (1,700 millimètres), Caffres (1,753), and the Maoris of New Zealand (1,757). To compare these with the stature of European peoples, we find that

that of the English and Irish is 1,690 millimètres; the Scotch, 1,708; Swedes, 1,700; Norwegians, 1,728; Danes, 1,685; Germans, 1,680; French, 1,667; Italians, 1,668; and, lastly, the Spaniards and Portuguese, 1,658.

The greatest circumference of the head is found among the Patagonians (614 millimètres) and Maoris (600). Following these are the Caffres (575), Nikobars (567), North Sclaves (554), Congo Negroes, South Chinese, and Kanaks (553), Tagals, Sundanese, and Roumanians (552), Japanese (550), Bugis and Jews (545), Amboinese (544), Javanese (542), Hottentots (540), and, lastly, the Zinganis and Siamese (529). Stature and circumference of head generally stand to each other in opposite relations; although there are exceptions, as in the case of the Siamese with small stature and small head, and the Patagonians with great height and large head.

The breadth of the root of the nose is found greatest among the Patagonians (41 millimètres), less among the Congo Negroes (36), Australians, Maoris, and South Chinese (35), Sundanese, Amboinese, Bugis, Nikobars, Tagals, and Kanaks (34), North Chinese, Caffres, North Sclaves, Roumanians, Magyars, and Zingani (33), Jews, Japanese, Siamese, Javanese, and Hottentots (32).

The Jews and Patagonians excel in length of nose (71 millimètres). Following these are the Kanaks (54), Roumanians (53), North Sclaves and Maoris (52), Tagals (51), Japanese and North Chinese (50), Siamese, Magyars, Zingani, Madurese (49), Amboinese (48), Nikobars (47), Sundanese, Javanese, South Chinese, Caffres (46), Hottentots (44), Congo Negroes (42), Bugis (41), and Australians (30).

The breadth of the nostrils gives quite another arrangement. Here we find the Australians excel (52 millimètres); then come Congo Negroes (48), Caffres and Patagonians (44), Tagals (42), Nikobars (41), Hottentots and Sundanese (40), Malay races (39), South Chinese (37), North Chinese (36), Japanese, North Sclaves, Roumanians, Zingani (35), Magyars and Jews (34).

With regard to the bust, it is found that the North American Indians and the Polynesians excel all others in size. Next to them come the North, Middle, and East Europeans; after them come the West Europeans, Negroes; and after them the South Europeans, who are followed by the East Asiatics and Malays.

Among European peoples, in respect of race, we find the narrowest chests among the Semites, followed in order by Romanee, Celts, Fins, Zingani, Germans, and Sclaves.

Interesting results are obtained by comparison of the length of the arm and leg bones. Among East Europeans the leg bones throughout are longer than the arm; among Australians, Polynesians, and especially East Asiatics and Patagonians, the leg bones are shorter than the arm; among Africans only the Congo Negroes have the leg bones longer than the arm.

Dr. von Scherzer, to whose paper we are indebted for these details, points out some important conclusions to be drawn from

these data as to the classification of races of men. These we have no space to go into. While, of course, it would be quite misleading to build any classification upon anthropometric measurements alone, their importance, when obtained in large numbers, and with trustworthy accuracy, as a help to anthropologists is very great.

The Expression of Grief.—This has recently been a subject of investigation by an Italian physiologist, M. Paolo Mentegazza, who has studied with great care all the contractions which suffering produces in the human face, and endeavoured to arrive at an exact distinction of the phenomena of real from those of simulated sorrow. All the forms of dolorous hypocrisy he exposes mercilessly. The following, according to M. Mentegazza, are signs of feigned grief:—(1) the expression is nearly always exaggerated relatively to the cause of the grief; (2) the visage is not pale, and the muscular disturbance is intermittent; (3) the skin has its normal heat; (4) there is not harmony in the mimicry of grief, and one sees certain contractions, certain relaxations, which are wholly wanting in real grief; (5) the pulse is frequent, in consequence of the exaggerated muscular movement; (6) a surprise, or any object which vividly attracts the attention, suffices to make the tragic mask immediately fall off; (7) sometimes one succeeds in discovering among the tears, the sobs, and the most heartrending lamentations, the presence of a chuckle, which expresses, perhaps, the malignant pleasure of practising a deception; (8) the expression is very eccentric, or is wholly wanting in concentric forms.

Manners and Customs in Central Africa.—Commander Cameron, at the Sheffield meeting of the British Association, delivered an address on the manners and customs of the people of Urua, in Central Africa. Urua was one of the largest native states in Africa. It was bounded on the east by Tanganyika, on the north by independent tribes in Manguema, on the west by Ulunda, and on the south by mountains south of the lake of Bangueolo. The great chief was Kasongo, and the race was perhaps the most civilized in Central Africa. The chief claimed Divine honours. On his death all his wives save one were slaughtered at the grave, and the one whose life was not taken was handed over to the chief's successor. The spirit of the deceased prince was supposed to pass into the body of the successor.

The centre of the religion of the people was an idol, which was held in great reverence. The idol was placed in the midst of a dense jungle, and it had for wife one of the sisters of the reigning sovereign. Under the principal chief were smaller chiefs, who collected and paid over to the sovereign tribute. He had seen this tribute come in, and some of it must have come from distant parts of the country. There was a numerous class of wizards in the country who did a large trade in idols and charms. Many of the wizards were ventriloquists, and in this way the idols were made to give answers to the questions put to

them. Caste was very clearly defined in the race. No one dare sit down in the presence of the chief without permission, which was very seldom granted. In one case where, in the traveller's presence, a native had neglected etiquette, severe punishment was about to be inflicted, but the traveller saved the offender.

Authority was maintained by mutilation. Hands, feet, ears, noses, were mutilated, and the natives did not seem to mind it much. One woman had cut off her own ears. This woman was one of Kasongo's wives; he had about 1,000 of them. She asked permission to mutilate herself, and she did it at once. The bodyguard of the chief was composed to a great extent of mutilated people, whose affection for the chief seemed in no way decreased. Indeed, it would appear that mutilation strengthened their regard for their chief. The name of the idol was Kungwe á Banza, and profound reverence was shown to it. Fire was obtained by friction from a fire-block, and in one case a chief used the shin-bone of one of the other chiefs who had been conquered.

The dress of the people was very simple, consisting of an apron. Members of the royal family wore three large skins, and junior members of the family wore aprons of green monkey-skins. The hair-dressing of this people was curious, varying more with districts than with rank. In some cases it was worked up into four ring-plaits crossed at the top of the head like a crown, and surrounded at the bottom with a band of cowries or other shells. Skewers were inserted in the hair, one end of which could be used in tattooing. The people were not a hairy race, but they managed to grow their beards long, and plaited them like a Chinaman's pigtail, usually putting at the end of each a lump of mud to weight it. Some of the beards reached to the waist. The women, not having beards to amuse themselves with, were tattooed extensively. Tattooing usually commenced at the age of seven and might be completed about the age of twelve or fourteen, which was the time for marriage. Beautiful patterns were used, and the tattooing was done in raised cuts. Sometimes a husband when he was displeased with his wife cut off all these raised pieces, and the woman could not appear in public again; she was not received into society until she was re-tattooed.

He saw one of their weddings, which was very curious. The festivities lasted several days. A ring was formed of the natives, two men with big drums being in the centre. The drums were played and the people round danced. The bride was brought out, dressed in feathers and other finery, on the shoulders of two or three women; she was taken into the centre of the ring and was jumped up and down on the shoulders of the women. The bride threw shells and beads about, for which there was a scramble, as the possession of them was supposed to confer luck. Ultimately the husband came into the ring, and putting the bride under his arm, carried her off.

The means of communication was by drum-signals. They had a call on the drum for everybody's

name, and they could ask questions and convey intelligence over hundreds of miles and receive answers almost immediately. In war messages were constantly sent enormous distances to bring up reinforcements or to stop their coming.

The mass of the people lived in huts on dry land, but there were one or two exceptions to this. He saw two lakes on which people were living in huts. In one case the people had covered over the long grass growing in the water with earth, and on that had built their huts; in the other the huts were built on piles. The language of the country belonged to the same broad family which stretched across the large belt of Africa traversed by him, and the grammar was on the same principle as the grammar of the Swaeli.

Statistics of Old Age in Austria.—Herr Max Waldstein, an officer of the Department of Administrative Statistics in Vienna, has published some interesting observations on "the oldest classes of the population of Europe," based upon the latest information concerning the population of the principal European States. There are in these countries 102,831 persons over 90 years old, of whom 60,303 are women, and 42,528 men. The superior vitality of women manifests itself still more strikingly among those who have reached a century, or exceeded it. Of this category there are in Italy 241 women, and 161 men; in Austria, 229 women, and 183 men; in Hungary, 526 women, and 524 men. The number of persons in the Cis-Leithian portion of the Austrian Empire who are more than 60 years old is 1,508,359, which is 7·5 per cent. of the whole population. Those provinces of Austria which are wholly or chiefly German stand almost at the top of Europe in the longevity of their inhabitants. Thus, for example, the persons over 60 constitute, in the province of Lower Austria, 8·4 of the whole population; in Upper Austria, 11·4; in Salzburg, 11·6; in Styria, 9·4; in Carinthia, 10·2; and in the Tyrol, 10·9. What reduces the total proportion of old people for Cis-Leithia is the fact that the number over 60 in the Slavonic provinces is considerably less. Thus, in Galicia and the Bukovina, it drops down to 4 per cent. of the whole. Hungary has 941,009 inhabitants who are over 60 years, of whom 486,596 are men, and 454,413 women. The excess in the male sex here is attributed to the fact that throughout the Hungarian provinces the preponderance of females generally over males is much less than is usual elsewhere, and in Croatia and Slavonia the number of males is greater. There are in Austria 100 women and 86 men who are a century old, 41 women and 37 men who are 101 years old, and 83 women and 60 men who are still older.

The Crania of Eminent Men.—It has been commonly accepted as a fact in anthropological science that the cranium of Descartes was small, and this has often been referred to as against the assertion that a large cranium is necessary for high intellect. No exact measurement, however, of the skull of the great philosopher seems to have been published in proof of what was stated. Lately

Dr. Le Bon has examined it along with others in Gall's collection, and he finds that this supposed small cranium has a capacity of 1,700 cubic centimètres, which is 150 cubic centimètres above the average of Parisian crania at the present time, viz., 1,550 cubic centimètres.

Of the 25 crania of distinguished men in the collection there is only one which is very considerably under the average. It is that of Roquelaure de Bessuejouls, 1,365 cubic centimètres. He was Bishop of Senlis, Chief Aumonier to Louis XV., and a member of the French Academy; a man of very mediocre talent. After him, with increasing capacity of skull, comes Alxinger, a now forgotten poet, 1,505 cubic centimètres; Wurmser, an Austrian general, always defeated, 1,510 cubic centimètres; Juvenal de Ursins, Chancellor under Charles V., 1,525 cubic centimètres.

The others are above the average, and we merely note the following among them: Boileau, 1,690 cubic centimètres; Gall, 1,692 cubic centimètres; Descartes, 1,700 cubic centimètres; Chinevin (eminent chemist), 1,700 cubic centimètres; De Zach (astronomer and mathematician), 1,715 cubic centimètres; Marshal Jourdan, 1,725 cubic centimètres; David (able mathematician), 1,725 cubic centimètres; Cassaigne (distinguished lawyer), 1,755 cubic centimètres; Abbé Gautier (author of well-known educational works), 1,770 cubic centimètres; Volta, 1,850 cubic centimètres; Spurzheim, 1,950 cubic centimètres, and La Fontaine (who carries the palm), 1,950 cubic centimètres. If it holds generally good that high intellect requires a large cranium, it is by no means necessarily the case that a large cranium implies high intellect.

We learn from *La Nature* (which furnishes the above data) that Dr. Bordier has recently measured 36 crania of guillotined murderers in the museum of Caens. Their average was very respectable, viz., 1,547·91 cubic centimètres. The most capacious, 2,076 cubic centimètres, was evidently pathological. None of them fell below 1,300 cubic centimétres. The French crania at the last anthropological exhibition, and which were those of criminals who had died in prison, had mostly capacities much above the average. Several of them, 12 out of 39, had a capacity superior to 1,600 cubic centimètres, and one was as high as 1,950 cubic centimètres. It is evident that the relations between capacity of the cranium and intelligence are somewhat complicated. In different species, too, the relations of the function to the organ are different.

Native Races of the Head Waters of the Zambesi.—A very curious account was given by Major Pinto, at the Sheffield meeting of the British Association, of the native races of the head waters of the Zambesi. He said that this district of the country, in which he had spent a considerable period, was inhabited by a race of people, one section of which seemed to have come from the north and the other section from the south. In Bihe—the district to which he referred—

he thought it was clear there was a mixture of races. There were negro characteristics, such as curly hair, thick lips, &c., but some of the people had Caucasian features, and they might very well, so far as features were concerned, pass for Europeans. Portions of this race must have come into the country within a century. Some of them were great hunters, and others near the streams cultivated the land. The hunters were very brave, and attacked the elephant without spears or anything beyond a simple bow and arrow. He thought this was very rare, poisoned arrows and spears being used always where the natives had not guns. The people were very fond of their beards, and ornamented them with great delight. The people living in the Ambula district cultivated the land, and irrigation was practised. He had seen women in the districts of which he was speaking who, if they were of a lighter complexion, would be considered extremely handsome in Europe. The people in the Ambula live on roots, which were not particularly nutritious, but the people were remarkably strong.

Amongst the Turcomans.—A paper by Professor Arminius Vambery was read at the meeting of the British Association on "The Turcomans between the Caspian and the Merv." The author said, in the course of his remarks, that the Turcoman tribes inhabiting the western portion of the great Turanian desert, though split up into hostile divisions, have never lost their purity of race and language, and are Turks *par excellence*. They have avoided intermixture, and retain the genuine Turkish physical type, not exhibiting the peculiarities of those Turks who live in the north-east of Central Asia, and form a transition to the Mongol race. The purest Turcoman type is found in the Tekes (particularly the Tchaudors and Imolis), while the Goklans, a fraction of the Yomuts, and the Eusaris are the most degenerate. The Salars or Salors, a tribe now living to the south-east of Merv, are the first mentioned in history, and next to them, the Guz or Gozz, formerly living near the present Andkhoi.

The general characteristic of the Turcoman tribes is a surpassing love for a wandering life, resulting in the avoidance of any change (except in two isolated cases), owing to the influence of political revolutions or Buddhistic or Islamite culture, which have affected the Kazaks and other Turkish tribes. Thus they show a laxity in the observation of the Mahometan tenets, and exhibit many remnants of the Shaman faith. Although superficially decidedly more savage than the tribes to the north and north-east, many of the fine qualities of the unsophisticated primitive life of the Turkish race are retained by them.

As to their number, it is believed that the figure of 1,000,000 is more likely to be increased than diminished by any statistics possible. The Tekkes are now the most numerous, and next to them the combined Yomuts of Khiva and on the Gorgan. Those of the ancient tribes who, from their position, first came in contact with the political movement

from Turan to Iran, were the first to diminish; and the Tekkes, heretofore sheltered by Persian anarchy, will now probably share the same fate under the Russian supremacy. They have always been fierce soldiers and dauntless adventurers.

Nothing can exceed the sterility and nakedness of the Turcoman steppes, which serve only as a temporary abode to the Kazaks, but are often used of necessity as a home by the Turcomans. The Yomuts in the south of Khiva have adopted a half-settled life, tilling the soil and attending much to irrigation. They would do so still more if not too severely taxed by the Khans of Khiva. Similar but weightier exactions have prevented the Tekkes and other tribes from settling on the Attrek and in similar localities suitable for agriculture, and have given rise to devastating inroads by the Persians, repaid by foraging and plundering expeditions called Alaman. But as the Kazaks, formerly man-stealers and robbers, now permit unmolested intercourse to a certain extent, there is no reason why the Turcomans, if properly met, should not also abandon their cruel and plundering habits, especially as they still retain a rigid observance of their plighted word. They also show family love, respect females, practise hospitality, and have an ineradicable love of independence.

The Colour of Human Hair.—Among the physical characteristics upon which the anthropologist relies in the discrimination of the several modifications of mankind, the colour of the hair is undoubtedly one of the most constant. And yet but little is really known respecting the cause of the differences in colour, and the distinctive characters of the various capillary pigments. It is, therefore, with satisfaction that we point to a paper on this subject by Mr. H. C. Sorby, which appeared during the year covered by the present volume of the 'Year Book of Facts" in the *Journal of the Anthropological Institute*. The paper describes some researches in which Mr. Sorby has endeavoured to isolate the pigments of the hair, and to subject them to chemical and spectroscopic scrutiny. He concludes that hair is a colourless horny substance tinted in different specimens by three, or possibly four, distinct pigmentary bodies. Ordinary solvents, such as water and alcohol, have no action on the pigments, since these are protected by the horny matter. Sulphuric acid, more or less dilute, appears to be the best medium for separating the colouring principles. By the action of such a reagent it is of course possible that decomposition may be effected, and products thus obtained which are not originally present in the hair. Mr. Sorby, however, is far too practised an experimentalist to be led astray by mistaking a product for an educt. He obtains from different kinds of human hair a reddish, a yellow, and black pigment. Possibly the red, which is an unstable body, may pass into the yellow by a process of oxidation. Very red hair is characterised by the presence of the red constituent, unmodified by other pigments; dark-red hair contains also some of the black

colouring matter; golden hair has less of the red and more of the yellow principle; in sandy-brown hair the black and red constituents are associated with a large proportion of yellow matter; in dark-brown hair the black pigment increases at the expense of the others; while in black hair this dark colouring substance completely overpowers the associated bodies. It is notable that Mr. Sorby found in some very black hair of a negro just as large a proportion of red pigment as in a very red hair of European origin. We may, therefore, safely conclude that if this negro should have failed to develop the black pigment his hair would have been, not white, but as bright a red as that of any red-haired European.

The Influence of Brain Work on the Growth of the Skull and Brain.—Messrs. Lacassagne and Cliquet have communicated an interesting paper on this subject to the Société de Méd. Publique et d'Hygiène Professionnelle. Having the patients, doctors, and attendants, of the Val de Grace at their disposal, they measured the heads of 190 doctors of medicine, 133 soldiers who had received an elementary instruction, 90 soldiers who could neither read nor write, and 91 soldiers who were prisoners. The instrument used was the same which hatters employ in measuring the heads of their customers; it is called the conformator, and gives a very correct idea of the proportions and dimensions of the heads in question.

The results were in favour of the doctors; their frontal diameter was also much more considerable than that of the soldiers, &c. Nor are both halves of the head symmetrically developed: in students, the left frontal region is more developed than the right; in illiterate individuals, the right occipital region is larger than the left. The authors have derived the following conclusions from their experiments: 1. The heads of students who have worked much with their brains are much more developed than those of illiterate individuals, or such as have allowed their brains to remain inactive. 2. In students, the frontal region is more developed than the occipital region, or, if there should be any difference in favour of the latter, it is very small; while, in illiterate people, the latter region is the largest.

The Aborigines of Australia.—At a meeting of the Anthropological Institute in the early part of 1879 a paper was read from Mr. D. Macallister on the Australian Aborigines. After describing their social and domestic observances, traditions, and religious notions, the author concluded that he had no doubt that, had the continent of Australia remained undiscovered by Europeans for a few thousand years longer, the climatic and general physical changes which would doubtless have occurred, together with the contact at intervals with their more civilised Polynesian neighbours, would have constituted an environment more favourable to progress than any which has ever existed, and would also have tended to an improved condition of the people. As it was, the total absence from the continent of ferocious or powerful

animals, and the comparative ease with which the poor and limited quantity of their food was obtained, and their national isolation, may have been a potent cause for the non-progressive character of the people.

Celtic in the British Isles.—A paper on the Celtic-speaking population of the British Isles was read by Mr. E. G. Ravenstein, F.R.G.S., &c., before the Statistical Society, in the spring of 1879. Besides consulting the census returns, so far as available, and other printed sources, the author mentioned that he had sent out no fewer than 1,250 circulars addressed to registrars of births, clergymen, schoolmasters, and, where these failed him, to innkeepers. Four Celtic languages, he said, are at present spoken in the British Isles—three belonging to the northern Gaelic, or Gadhelic, and one to the southern, or Cymraig branch. The former are Irish Gaelic, Scotch Gaelic, and Manx. Welsh alone represents the Cymraig, since the extinction of Cornish. Up to the time of the Reformation, which led to its extinction, as it did to that of the Celtic spoken in Strathclyde, in Cumberland, Cornish was spoken as far as the Tamar. In 1707 English had become vernacular throughout Cornwall, although Cornish lived on in 23 parishes. In 1791 there was only one person alive able to speak Cornish.

Mr. Ravenstein began his general survey with Ireland. He showed that a comparison of the census returns for 1871 with those for 1851 gives a very clear notion of the manner in which a language, fallen into disuse among the educated classes, dies a lingering death in the face of a more vigorous usurping tongue. In 1851, Irish (or Irish in addition to English) was spoken by 1,524,286, or 23·3 per cent. of the population; in 1861, by 1,105,536, or 19·1 per cent.; in 1871, by 817,875, or 15·3 per cent. Hence the absolute decrease was 27·4 per cent. between 1851 and 1861, and 26·2 per cent. between 1861 and 1871. The slightly smaller decrease in the second interval did not prove that Irish was regaining lost ground, if we took into account the relative decrease of the Irish population. Mr. Ravenstein owned, however, that something had been done by the Society for the Preservation of the Irish Language in staying the decline.

The disuse of Manx had also become rapid since the beginning of the present century, and the only parish church in which a Manx sermon can now be heard is that of Kirk Arbory. Occasionally, however, the Wesleyans use Manx in their chapels. In 1871, out of 54,042 inhabitants, 190 spoke Manx only, and 13,600 both tongues—*i.e.*, 25·6 per cent. still understood Manx.

In Scotland not quite 9 per cent. of the total population is able to speak Gaelic, and eight-tenths of these are distributed over nearly half the area of the country, where they are in the majority. Thus, while in the Saxon districts there are as many as 206 to the square mile, in the Gaelic Highlands there are only 17. The Gaels, like their kinsmen in Ireland and England, and like many a small tribe in other

lands, have been driven into the hills, or have only kept their footing in the more fertile lowlands by amalgamation with the intruding Saxon.

The review of the Welsh counties led to the result that it is in the Principality that the Celts, or Kelts, seem likely to make their last stand for their old tongue and other race characteristics.

Mr. Ravenstein's final figures still allotted 857,000 to the speakers of Irish Gaelic; 12,500 to those understanding Manx Gaelic, at least along with English; 305,000 to Scotch Gaelic; and upwards of a million to the speakers of Cymraig, including those knowing English as well, for Wales.

High Africa the Centre of a White Race.—At the Sheffield meeting of the British Association, Mr. Hyde Clarke read a paper on this subject. The object of the paper was to support a division proposed by the author between the Aryans and the other white races of early historical epochs. Treating the Akkad-Babylonians, Lydians, Canaanites, Etruscans, as the ancient types of the non-Aryan white races, he proposed as modern representatives the Georgians, Circassians, Armenians, Kurds, Persians, Afghans, and Greeks of Scioxa. The migrations and historical incidents of the non-Aryan whites were, he said, to be accounted for by a migration from Africa and a habitat in High Africa. He showed that the languages of the great States of Africa belong to a like class with the Akkad, Lydian, Phrygian, Thracian, Etruscan, Georgian, &c. He referred also to the community of mythological origins. The traditions of Abyssinia treated it as a paradise and the cradle of the world. To the white race he gave the name of Turano-African, and assigned to it the foundation of Egypt, of the great empires of Asia, and the kingdoms of southern Europe and northern Africa. He attributed to it not only a knowledge of North and South America and Australia, but also the occupation of those regions, the evidences of which are found in their languages, mythology, and monuments.

In a Cannibal Country.—At the Sheffield meeting of the British Association, Count S. de Brazza delivered an address on the native races of the Gaboon and Ogowa. He spoke highly of the generous sentiments of the people, and he had himself experienced great kindness in the cannibal country. The people ate the hearts of their brave enemies, believing that by so doing their own courage would be increased. Those who supposed that cannibals were wanting in generous feelings made a great mistake. The cannibals had many good qualities, and were not altogether the savages they were frequently painted. Cannibals had been known to die defending European travellers.

The Origin and Progress of the Human Race.—In the department of Anthropology, at the Sheffield meeting of the British Association, the opening address was delivered by Dr. E. B. Tylor. He said,—Looking back 4,000 to 5,000 years, what is the appearance of mankind as disclosed to

us by the Egyptian monuments and inscriptions? Several of the best-marked races of man were already in existence, including the brown Egyptian himself, the dark-white Semitic man of Assyria or Palestine, the Central African of two varieties, which travellers still find as distinct as ever—namely, the black or negro proper, and the copper-coloured negroid, like the Bongo or Nyam-nyam of our own time. Indeed, the evidence accessible as to ancient races of man goes to prove that the causes which brought about their differences in types of skull, hair, skin, and constitution, did their chief work in times before history began. Since then the races which had become adapted to their geographical regions may have, on the whole, undergone little change while remaining there; but some alterations are traced as due to migration into new climates. Even these are difficult to follow, masked as they are by the more striking changes produced by intermarriage of races. Now, the view that the races of man are to be accounted for as varied descendants of one original stock, is zoologically probable from the close resemblance of all men in body and mind, and the freedom with which races intercross. If it was so, then the fact of the different races already existing early in the historical period compels the naturalist to look to a pre-historic period for their development to have taken place in. And, considering how strongly differenced are the Negro and the Syrian, and how slowly such changes of complexion and feature take place within historical experience, this pre-historic period was probably of vast length.

The evidence from the languages of the world points in the same direction. In times of ancient history we already meet with families of languages, such as the Aryan and the Semitic, and as later history goes on many other families of language come into view, such as the Bantu or Caffre of Africa, the Dravidian of South India, the Malayo-Polynesian, the Algonquin of North America, and other families. However far we go back the signs of development from still earlier stages are there. The arguments in favour of man's antiquity derived from race, language, and culture, stand on their own ground. In connection with the question of quarternary man, it is worth while to notice that the use of the terms "primeval" or "primitive" man with reference to the savages of the mammoth period seems sometimes to lead to unsound inferences.

There appears no particular reason to think that the relics from the drift-beds or bone-caves represent man as he first appeared on the earth. The contents of the caves especially bear witness to a state of savage art, in some respects fairly high, and which may possibly have somewhat fallen off from an ancestral state in a more favourable climate. Indeed, the savage condition generally, though rude and more or less representing early stages of culture, never looks absolutely primitive; just as no savage language ever has the appearance of being a primitive language.

What the appearance and state of our really primeval ancestors

may have been seems too speculative a question, until there shall be more signs of agreement between the anthropologists, who work back by comparison of actual races of man toward a hypothetical common stock, and the zoologists, who approach the problem through the species adjoining the human. There is, however, a point relating to the problem to which attention is due. Naturalists not unreasonably claim to find the geographical centre of man in the tropical regions of the old world inhabited by his nearest zoological allies, the anthropomorphous apes, and there is at any rate force enough in such a view to make careful quest of human remains worth while in those districts from Africa across to the Eastern Archipelago. Under the care of Mr. John Evans, a fund has been raised for excavations in the caves of Borneo by Mr. Everett, and though the search has as yet had no striking result, money is well spent in carrying on such investigations in likely equatorial forest regions. It would be a pity that for want of enterprise a chance, however slight, should be missed of settling a question so vital to anthropology.

While the problem of primitive man thus remains obscure, a somewhat more distinct opinion may be formed on the problem of primitive civilized man. When it is asked what races of mankind first attained to civilization, it may be answered that the earliest nations known to have had the art of writing, the great mark of civilization as distinguished from barbarianism, were the Egyptians and Babylonians, who in the remotest ages of history appear as nations advanced to the civilized stage in arts and social organization. The question is under what races to class them. What the ancient Egyptians were like is well known from the monuments, which show how closely much of the present fellah population, as little changed in features as in climate and life, represent their ancestors of the times of the Pharaohs. On the whole, the Egyptians may be a mixed race, mainly of African origin, perhaps from the southern Somali-land, whence the Egyptian tradition was that the gods came, while their African type may have since been modified by Asiatic admixture. So ancient was civilization among both Egyptians and Chaldeans that the contest as to their priority in such matters as magical science was going on hotly in the classic ages of Greece and Rome.

While speaking of the high antiquity of civilization in Egypt, the fact calls for remark that the use of iron, as well as bronze, in that country seems to go back as far as historical record reaches. Brugsch writes, in his "Egypt under the Pharaohs," that Egypt throws scorn on the archæologists' assumed successive periods of stone, bronze, and iron. The eminent historian neglects, however, to mention facts which give a different complexion to the early Egyptian use of metals—namely, that chipped flints, apparently belonging to a prehistoric stone age, are picked up plentifully in Egypt, while the sharp stones or stone knives used by the embalmers seem also to indicate

an earlier time when these were the cutting instruments in ordinary use. Thus there are signs that the metal age in Egypt, as elsewhere in the world, was preceded by a stone age; and, if so, the high antiquity of the use of metal only throws back to a still higher antiquity the use of stone.

The writer then passed on to consider the comparative study of laws and customs and their bearing on the question of man's antiquity. He instanced a case of resemblance in the law of inheritance among the Orang Dongo, a mountain people in the Malay region, and the old Kentish law of gavelkind.

He next discussed the present state of comparative mythology, and said that no doubt many legends of the ancient world, though not really history, are myths which have arisen by reasoning on actual events. When the science of man was just coming into notice, it seemed as though the study of races, customs, traditions, were a limited though interesting task, which might, after a few years, come so near the end of its materials as no longer to have much new to offer. Its real course has been far otherwise. Twenty years ago it was no difficult task to follow it step by step; but now even the yearly list of new anthropological literature is enough to form a pamphlet, and each capital of Europe has its Anthropological Society in full work. So far from any lack of finality in anthropological investigations, each new line of argument but opens the way to others behind, while these lines tend as plainly as in the sciences of stricter weight and measure toward the meeting-ground of all sciences in the unity of nature.

Domestication and Brain Growth.—Dr. Crichton Browne delivered an address before the British Association, on "Influence of Domestication on Brain Growth." He had found by experiments that domestication had greatly reduced the brains of the duck, and he argued that men, like ducks, might be fed and housed, fenced about, and exempted from participation in the life struggle until, like the ducks, they would depreciate in mental capacity. Their bodies might increase in size and succulence; but their brains would become straitened and withered. Disease and luxury crippled the brains. It was as true as ever that men were perfected through suffering, toil, and conflict, and it was not through affluence and comfort that genuine civilization was attained. It was the civilization, not merely the domestication of mankind, that must be aimed at.

II.—THE WORLD OF PLANTS AND ANIMALS.

The Effect of Coloured Light on Animal Life.—Owing to the numerous experiments of which plants have been the object, we now know that the different coloured rays of the solar light have a particular action on the processes of the nutrition of those organised beings. As to their effect on the development of animals, the researches are far less numerous and complete. M. Béclard had made some experiments with different parts of the spectrum on the eggs of the fly (*Musca carnaria*), and found that they hatched much more quickly under the violet and blue rays than under the green. M. Yung has for three years been investigating this subject at the Zoological Laboratory at Roscoff (Brittany). Three series of observations were made on the eggs of the *Rana temporaria*, the trout (*Salmo trutta*), and the *Lymnea stagnalis*. Other conditions being identical, the eggs were subjected, in separate portions, to different coloured lights. One vase of each was kept in a dark cupboard.

The conclusions, identical in each case, were as follows:—(1) The different coloured rays of solar light act in very varied ways on the development of the eggs; (2) the violet light hastens the hatching in a very remarkable manner, and is very closely followed, in that respect, by the blue, then the yellow, and the white; (3) the red and green rays appear injurious in this sense, that under their influence complete development of the eggs was never obtained; (4) darkness does not prevent the development, although it delays it considerably; (5) the various parts of the spectrum may be thus arranged, in their effect on development, in the following decreasing order: violet, blue, yellow, and white (almost identical), darkness, red and green (prevent development); (6) the tadpoles of frogs, of the same size, and previously existing under precisely similar conditions, deprived of all nourishment, died much quicker of inanition in the violet and blue rays than the others, because they consumed more rapidly their accumulated alimentary stores; (7) the mortality appeared greater in the coloured lights than in white. However, that point is not so certain, and requires further investigation before pronouncing a positive decision.

The Grazing Habits of Common Limpits.—In a communication to the Linnean Society, Mr. J. C. Hawkshaw gives an account of the grazing habits of the common limpet, as observed on that coating of delicate seaweed which abounds on the chalky coast of Kent. In eating the weed, the limpets remove also a thin layer of chalk; and the white patches left by them show that a single

limpet will clear more than an inch square in area in a single tide. First a small groove is made in the chalk, and by repetition of the process the groove is gradually widened; and if the limpet should be excursive, becomes a zigzag more than a foot in length. From observation, Mr. Hawkshaw calculates that ten limpets would keep clear a square (superficial) foot of chalk; and he says that, in any case, they do more to destroy the rock-surface than the sea ordinarily does. The eastern beach at Dover is a good locality for observing that limpets not only graze, but that, in some instances, they dig pits. Beyond the Atlantic there are, it is told, limpets a foot in diameter. "If," remarks Mr. Hawkshaw, "the proceedings of these South American giants are at all the same as those of the limpets of our own shores, and are in proportion to their size, they must materially aid in the encroachment of the sea on the land when the rock happens to be soft."

Sugar in Beetroot.—From experiments made recently in France, it has been ascertained that the amount of sugar in beetroot varies in direct proportion to the size of the leaves; that is to say, the larger the leaf the more sugar. Sugar exists also in the leaves; but in small quantity except in the midrib.

The Black Mildew of Walls.—Apropos of an observation by Professor Paley regarding the cause of the blackness of St. Paul's, which he attributed mainly to the growth of a lichen, Professor Leidy recently stated to the Philadelphia Academy that his attention was called a number of years ago to a similar black appearance on the brick walls and granite work of houses in narrow, shaded streets, especially in the vicinity of the Delaware River. Noticing a similar blackness on the bricks above the windows of a brewery, from which there was a constant escape of watery vapour, in a more central portion of the city, he was led to suspect it was of vegetable nature.

On examination, the black mildew proved to be an alga, closely allied to what he supposed to be the *Protococcus viridis*, which gives the bright green colour to the trunks of trees, fences, and walls, mostly on the more shaded and northern side, everywhere in that neighbourhood. Professor Leidy thinks it may be the same plant in a different state; but, until proved to be so, he proposes to distinguish it by the name of *Protococcus lugubris*. It consists of minute round or oval cells, isolated or in pairs, or in groups of four, the result of division; or it occurs in short irregular chains of four or more cells up to a dozen, occasionally with a lateral offset of two or more cells. The cells by transmitted light seem of a brownish or olive-brownish hue. In mass, the alga appears to the naked eye as an intensely-black powder.

The Market Price of Wild Beasts.—This is given by the *Live Stock Journal*, which states that an Austrian firm of dealers in wild animals has published a sort of wholesale price list, in which it is announced that lions and tigers can be had upon the average for £80; spotted panthers

for £30, and leopards for £20; while a black panther is worth £150, and a spotted tiger as much as £300. Jaguars are quoted at from £30 to £50, the American tiger-cat at from 50*s*. to £10, and the hyæna at from £12 to £30. An ichneumon is worth, upon the average, £25, and a wolf from £5 to £10. The prices of bears are as under:—the common bear, £8; the brown bear, £10; the black and Syrian bear, £12; the Japanese or Himalayan bear, £15; and the white bear, £25. The price of a rhinoceros varies from £400 to £1,000; and African elephants cost £60, while the Indian variety runs from £150 to £300. The price of a pair of kangaroos varies from £10 to £60, and the price of monkeys also varies very much, from a pound for small monkeys of the ordinary kind, to £100 for the chimpanzee or the ourang-outang.

Curiosities of Nectar.—The sweet substance, nectar, found in blossoms and flowers, has been subjected to experiment by Mr. Wilson, who, from his results, has worked out some curiously-interesting calculations. For example: 125 heads of clover yield approximately 1 gram of sugar; 125,000 heads yield 1 kilogram, and as each head contains about 60 florets, 7,500,000 distinct flower-tubes must be sucked in order to obtain 1 kilogram of sugar. "Now," continues Mr. Wilson, "as honey, roughly, may be said to contain 75 per cent. of sugar, we have 1 kilogram, equivalent to 5,600,000 flowers, in round numbers, or say 2,500,000 visits, for 1 lb. of honey. This shows what an amazing amount of labour the bees must perform." A notable part of the sugar is cane-sugar, which is remarkable, for honey containing sugar-cane is looked on by dealers as adulterated. A nice question here arises as to the manner in which the nectar is converted into cane-sugar while in possession of the bee. It is worthy of notice that in this country the fuchsia does not part with its nectar, in consequence of the nectary being inaccessible to native British insects.

The Rocky Mountain Locust.—The extensive injury done in America by this insect led to the appointment, recently, of a government commission to investigate the subject. Their report, now published, contains much interesting information, of which the following is part. The locust area is of immense extent; it lies between the 94th and the 120th meridians, embracing nearly 2,000,000 square miles. During the years 1874–77, the direct and indirect losses caused by the insect in states and territories lying west of the Mississippi and east of the great plains are estimated at not less than $200,000,000. The commission have succeeded in mapping the breeding grounds and districts subject to invasion, and indicating the directions taken by invading and returning armies.

As a rule, flight is undertaken only during a part of the day, and in fair, clear weather. The desire for food, cloudy or rainy weather, and adverse winds may keep the locusts from taking wing. In all flights they rely much on the wind to carry them, usually turning their heads towards it and drifting

backwards. With slight winds, however, they use their wings and turn their heads forward. They sometimes travel several days continuously, and several hundred miles. Their velocity varies from 3 to 15 or 20 miles an hour, according to that of the wind. It appears they can fly 2½ miles above the general surface of Kansas and Nebraska, and far beyond the keenest vision. This explains their sudden and mysterious appearance in some areas. Two swarms have sometimes been seen moving in opposite directions; one in an upper and one in a lower current. There is a tendency in broods hatched in a visited area to return to the native habitats whence their progenitors came.

The laying season is six to eight weeks, the average interval of laying two weeks, and the average number of egg-masses o three. About seven weeks are required from hatching to attain full growth, the insect passing through six stages in that time. The locusts are not led by kings or queens. Their preferred food is the various cereals; but they will eat almost anything, at a push—even dry leaves, paper, cotton and woollen fabrics, and dead animals. They often strip fruit trees of their leaves. Blackbirds, prairie-hens, and quail are found to be good locust destroyers.

In discussing the uses to which locusts can be put, it is urged that they form an abundant and nutritious article of food. Good broth is made by boiling the unfledged insects for two hours in a proper quantity of water, and seasoned with nothing but pepper and salt. It is said to be hardly distinguishable from beef broth. Boiled, fried, or roasted, the full-grown make pleasant food, and ground and compressed they will keep a long time. Other uses suggested are as fish bait, as manure, and as a source of formic acid.

The Buzzing of Insects Explained.—There are two classes of insects which make a buzzing sound when they fly, those known as *Diptera* and *Hymenoptera*. How is the buzzing produced? has been often asked. A French naturalist has answered the question in a paper presented to the Academy of Sciences in Paris. The buzz unites a deep and a sharp sound. The deep sound comes from the wing, provided that the vibrations are sufficiently rapid. The sharp sound, an octave usually above the other, is produced within the thorax, as has been ascertained by experiment. A supposition prevailed that it was due to the passage of the air through the stigmata and the vibration of their valvules; but these openings have been stopped with birdlime, and yet the sharp sound continues. It keeps on even when the wings are cut off. The explanation is, that the insect still endeavours to fly, and, employing the wing muscles, occasions vibrations of the thorax, and thereby produces the sharp sound, more or less intense, according to the size of the insect.

The Place of Lizards in the Animal Kingdom.—At a recent meeting of the Royal Society, Professor Parker made a communication embodying part of his work on the structure and development of the skulls in the lizard group, which is of high

interest. His researches on the embryos of the common British lizards have led him to very unexpected results. Hitherto we have been accustomed to regard the crocodiles and turtles as the highest groups of the reptile family, chiefly on the evidence of the structure of the soft and more important vital organs. But the evidence from the skull leads Professor Parker to regard the lizards not only as the most highly specialised of reptiles, but the group which approaches most closely towards birds.

Hot Water for Drooping Plants.—M. Willermoz, in the French *Journal of the Society of Practical Horticulture*, relates that plants in pots may be treated with hot water when out of health, the usual remedy for which has been re-potting. He says that when ill-health ensues from acid substances contained or generated in the soil, and this is absorbed by the roots, it acts as a poison. The small roots are withered and cease their action, consequently the upper and younger shoots of the plant turn yellow, and the spots with which the leaves are covered indicate their morbid state. In such cases the usual remedy is to transplant into fresh soil, clean the pots carefully, secure good drainage, and often with the best results. But the experience of several years has proved with him the unfailing efficacy of the simpler treatment, hich consists of watering abundantly with hot water at a temperature of about 145° Fahrenheit, having previously stirred the soil of the pots as far as might be done without injury to the roots. Water is then given until it runs freely from the pots. In his experiments the water first came out clear, afterwards it was sensibly tinged with brown, and gave an appreciable acid reaction. After this thorough washing the pots were kept warm. Next day the leaves of two *Ficus elastica* so treated ceased to droop, the spread of black spots on the leaves was arrested, and three days afterward, instead of dying, the plants had recovered their normal look of health. Very soon they made new roots, immediately followed by vigorous growth.

Vegetating Animals.—An important line of demarcation between the vegetable and the animal world has been removed by recent investigation. Plants assimilate carbonic acid, give off oxygen, and form starch. By experiments on a species of *Planaria*, a flat worm, described as *Convoluta Schultzii*, Mr. P. Geddes has shown that that animal disengages large quantities of oxygen, decomposes carbonic acid, and produces starch. This worm abounds in the shallow water on the margin of the sea, and on exposure to sunlight pours forth a stream of bubbles containing, as proved by analysis, from 45 to 55 per cent. of oxygen. And on subjecting a number of Planaria to chemical treatment a quantity of ordinary vegetable starch was obtained. Pointing out the significance of these facts in the Proceedings of the Royal Society, Mr. Geddes says: "As the *Drosera* and *Dionæa* (two species of well-known vegetable Fly-traps), which have attracted so much attention of late years, have received the

striking name of Carnivorous Plants, these Planarians may not unfairly be called Vegetating Animals, for the one case is the precise reciprocal of the other. Not only does the *Dionæa* imitate the the carnivorous animal, and the *Convoluta* the ordinary green plant, but each tends to lose its own normal character."

An Octopus Blushing.—The octopus frequently changes in colour, like a marine chameleon. M. Fredericq, who has lately been studying this creature, finds that the coloured pigment whereby this is effected is contained in envelopes in the skin (he styles them *chromatophores*), in the tissue of which are muscular fibres actuated by nerves. If these fibres are relaxed a pale pigment is alone visible, but if the fibres contract a dark pigment appears. The nerve centre which dominates these actions is believed to be the subœsophagean ganglion, The phenomena are analogous to those of human blushing.

A Cure for the Coffee Disease.—Careful and continuous experiments have at last, it is confidently hoped, resulted in the discovery of a remedy for one, at least, and that the most serious, of the diseases under which the coffee plantations in Ceylon have long been suffering—viz., the red rust, or leaf disease (*Hemileia vastatrix*). The competition of Brazil, Central America, and even of the West and East Indies, and more lately the threatened competition of Liberia, have shaken the position of Ceylon as the principal coffee-producing country; and when a combination of diseases attacked her staple industry in a more insidious manner, planters began to look with anxiety at the future. The most destructive pest has been the "leaf disease," by which the leaves of the trees have been attacked by a fungoid growth, the spread of which it has hitherto been impossible to check. The leaves of the coffee plants have been covered with spots of apparent dust, which, spreading from leaf to leaf, from branch to branch, and from tree to tree, have ravaged large areas of country, until the plantations, instead of presenting a bright deep green colour, have assumed a dark orange hue; the health of the trees has suffered, and the production of berries deteriorated both in quality and quantity.

After many remedies, such as paraffin, dilute sulphuric acid, &c., had been used in vain, the experiment of dusting the leaves with finely-powdered sulphur was tried, with extraordinary success. The fumigation of the trees, by placing a large umbrella or tent-like structure over and round them, and burning sulphur within the closed space, has been almost equally efficacious, though naturally more cumbersome and difficult of application. Trees so treated are reported to have quickly assumed a healthy appearance, and if these effects are permanent, there is every probability of the disease being stamped out. Whether the same remedy will at the same time kill the spider, the white grub, and other insect pests which have combined in their attacks on the coffee plantations, remains to be seen. It is not a little remarkabl

that the application of sulphur to *hemileia* was coincident with, if not consequent on, the recent reports that sulphur had been found to be a cure for a similiar fungoid disease in the human being—viz., diphtheria. A fungus disease is rife among the salmon in certain English and Scotch rivers. It would apparently be worth while trying the effects of the cure there; though its application to large rivers presents serious difficulties.

Making a Queen Bee.—In a paper read to the Quekett Microscopical Club, Mr. J. Hunter states that a fertile queen bee will in four years lay a million eggs. Twenty-one days are necessary for the production of a worker-bee; "but the same egg that produced the worker in twenty-one days could, had the bees been so minded, have been bred up to a *queen* in sixteen days. The bees," continues Mr. Hunter, "only rear queens when necessity calls for them, either from loss of their old monarch or apprehended swarming. If I remove the queen from a hive, the first of these contingencies occurs, and after a few hours' commotion, the bees select certain of the worker-eggs, or even young larvæ two or three days old. The cell is enlarged to five or six times its ordinary capacity; a superabundance of totally different food is supplied; and the result is that, in five days less than would have been required for a worker, a queen is hatched. The marvel is inexplicable. How a mere change and greater abundance of food, and a more roomy lodging should so transform the internal and external organs of any living creature! The case is without a parallel in all the animal creation. It is not a mere superficial change that has been effected, but one that penetrates far below form and structure, to the very fountain of life itself. It is a transformation alike of function, of structure, and of instinct."

The Prevention of Insect Injury.—"The Prevention of Insect Injury by the Use of Phenol Preparations" is the title of a paper communicated during the year by a lady, who states that her plot of carrots being seriously affected by what is known as "rust" (*Psila rosæ*), an insect that in the larval condition works underground, she had them moistened with a mixture of water and the preparation sold as Little's Soluble Phenyle. This had been previously proved to be fatal to insect life, and at the same time favourable to vegetation; and it did not fail in the case of the carrots. To quote the lady's words: "In less than a fortnight the attack had ceased spreading, and some of the infected plants showed signs of recovery; in a another week healthy foliage was showing; and from that time till the 12th of August, when they were raised for examination, they continued to grow luxuriantly with no return of attack of the rust-fly."

Plants and roots watered with the dilute solution have a tarry smell, which is, however, removed by cooking; and the writer concludes by stating that she has found the Phenyle beneficial in all cases; and, "looking at the degree to which larval health is affected in many cases merely by the difference in the watery or condensed state of the sap, and

the general refusal of larvæ to feed at all unless the food is to their taste, it appears that a fluid so thoroughly distasteful as this—not simply soddening from the outside, but circulated by the vegetative action exactly in the young and growing tissues most liable to insect attack—might be of much service, at hardly appreciable cost, except the wages of a labourer for occasional application, and might even be brought to bear on the *Phylloxera*.

Sir John Lubbock on Ants.—Sir John Lubbock read two papers on ants before the Linnæan Society on the 6th of February, 1879. The first gave an account of their anatomy; but, from the extreme complexity of these interesting little creatures, it would be impossible to make his communications intelligible without the figures. The second paper was a continuation of his observations on the habits of ants. He observed that he had at first isolated his nests by means of water. This was effectual enough; but, especially in summer, the water required to be continually renewed. Kerner, however, had suggested that the hairs of plants served to prevent ants from obtaining access to the honey, and it accordingly occurred to him that strips of fur, arranged with the points of the hairs downwards, might answer his purpose. He had tried this, and, finding it successful, he thought a similar arrangement might, perhaps, be found useful in hot countries. It is generally stated that the queen ants alone lay eggs, but Sir John has found that in most of his nests some few of the workers are capable of doing so. It appears, however, that these eggs always produce males. In the case of bees, we know that the queen is fed on a special kind of food. In ants, it is not feasible to make observations similar to those by which, in bees, this has been established. It is, however, rendered more than probable by the fact that, while males and workers have been bred by hundreds in his nests, no queen has yet been produced.

M. Lespès has given a short but interesting account of some experiments made by him on the relations existing between ants and their domestic animals, from which it might be inferred that even within the limits of a single species some communities are more advanced than others. He found that specimens of the curious blind beetle *claviger*, which always occurs with ants, when transferred from a nest of *lasius niger* to another which kept none of these domestic beetles, were invariably attacked and eaten. From this he infers that the intelligence necessary to keep *clavigers* is not co-extensive with the species, but belongs only to certain communities and races, which, so to say, are more advanced in civilization than the rest of the species. Sir John Lubbock, however, removed specimens of the curious blind *platyartherus* from one nest to another, but they were always amicably received. He even transferred specimens from a nest of *lasius flavus* to one of *formica fusca*, with the same result.

As regards the longevity of ants, he has now two queens of *formica fusca* which seem quite

in good health, and which have lived with him since 1874. They are, therefore, probably five years old. He has also workers of *lasius niger, formica sanguinea, formica fusca,* and *formica cinerea,* which he has had under observation since 1875.

In his previous papers he has given various instances which seem to show that ants do not exhibit such unvarying kindness to their friends as has been usually supposed. He wished, however, to guard himself against being supposed to question the general good qualities of his favourites. In fact, ants of the same nest never quarrel among themselves; he had never seen any evidence of ill-temper in any of his nests. All is harmony. He had already in previous papers given various instances of tender kindness. Again, in one of his nests of *formica fusca* was a poor ant which had come into the world without antennæ. Never having previously met with such a case, he watched her with great interest, but she never appeared to leave the nest. At length, one day he found her wandering about in an aimless sort of manner, and apparently not knowing her way at all. After a while she fell in with some specimens of *lasius flavus,* who directly attacked her. He then set himself to separate them; but she was evidently much wounded, and lay helpless on the ground. After some time another *formica fusca* from her nest came by. She examined the poor sufferer carefully, then picked her up tenderly and carried her away into the nest. It would have been difficult, Sir John thinks, for anyone who witnessed this scene to have denied to this ant the possession of human feelings.

It is clear, from the experiments recorded in the present and in Sir John's former papers, that the ants recognize all their fellows in the same nest, but it is very difficult to understand how this can be effected. The nests vary very much in size, but in some species 100,000 individuals may probably be by no means an unusual number, and in some instances even this is largely exceeded. Now, it seems almost incredible that in such cases every ant knows every other one by sight; neither does it seem possible that all the ants in each nest should be characterised from those of other nests by any peculiarity. It has been suggested, in the case of bees, that each nest might have some sign or password. The whole subject is full of difficulty. It occurred to Sir John, however, that experiments with pupæ might throw some light on the subject. Although the ants of every nest, say of *formica fusca,* are deadly enemies to others, still if larvæ or pupæ from one nest are transferred to another they are kindly received, and tended with, apparently, as much care as if they really belonged to the nest. In ant warfare, though sex is no protection, the young are spared—at least, when they belong to the same species. Moreover, though the habits and dispositions of ants are greatly changed if they are taken away from their nest and kept in solitary confinement, or only with a few friends, still in such circum-

stances they will carefully tend any young which may be confided to them. Now, if the recognition were effected by means of some signal or password, then, as it can hardly be supposed that the larvæ or pupæ would be sufficiently intelligent to appreciate, still less to remember it, the pupæ which were intrusted to ants from another's nest would have the password, if any, of that nest, and not of the one from which they had been taken. Hence, if the recognition were effected by some password or sign with the antennæ, they would be amicably received in the nest from which their nurses had been taken, but not in their own. He, therefore, took a number of pupæ out of some of his nests of *formica fusca* and *lasius niger* and put them in small glasses, some with ants from their own nest, some with ants of another nest of the same species.

The results were that 32 ants belonging to *formica fusca* and *lasius niger*, removed from their nest as pupæ, attended by friends and restored to their own nest, were all amicably received. What is still more remarkable, of 22 ants belonging to *formica fusca*, removed as pupæ, attended by strangers, and returned to their own nest, 20 were amicably received. As regards one, Sir John was doubtful; the last was crippled in coming out of the pupæ case, and to this, perhaps, her unfriendly reception may have been due. Of the same number of *lasius niger*, developed in the same manner, from pupæ tended by strangers belonging to the same species, and then returned into their own nest, 17 were amicably received; three were attacked; about two Sir John felt doubtful. On the other hand, 15 specimens belonging to the same two species, removed as pupæ, tended by strangers belonging to the same species, and then put into the strangers' nest, were all attacked.

The results may be summarized as follows:—Pupæ brought up by friends and replaced in their own nest - attacked, 0; received amicably, 33. Pupæ brought up by strangers and put in own nest—attacked, 7 (about three of these Sir John did not feel sure); received amicably, 37. Pupæ brought up by strangers and put in strangers' nest—attacked, 15; received amicably, 0. Sir John intends to make further experiments in this direction; but the above results seem very interesting. They appear to indicate that ants of the same nest do not recognise one another by any password. On the other hand, if ants are removed from a nest in the pupæ state, tended by strangers, and then restored, some at least of their relatives are certainly puzzled, and in many cases doubt their claim to consanguinity. Strangers in the same circumstances would be immediately attacked. These ants, on the contrary, were in every case, sometimes, however, after examination, amicably received by the majority of the colony, and it was often several hours before they came across one who did not recognise them.

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III.—GEOGRAPHICAL NOTES AND TRAVELLERS' TALES.

The Highest House in the World.—The United States Signal Service Station at Pike's Peak is the highest signal station in the world; it is also the highest inhabited portion of the globe. It was opened in September, 1873. It is under the charge of three selected army officers. Seven observations are taken daily, and all storms are closely watched. The summit of Pike's Peak contains 60 acres. It is 14,336ft. above the level of the sea. On the highest point of the summit stands the signal station—a rough stone building, 24 by 30, one story in height. It is divided into four rooms—officers' room, kitchen, store-room, and wood-room. The station is three miles from the timber line, where the greater part of vegetation ceases. Short grass, tufted with delicate Alpine flowers, struggles for an existence against the frigidity of the atmosphere, and creeps towards the mountain top; but there are hundreds of acres of cold grey and reddish rocks, where not a vestige of verdure exists.

Like the dwellers of the Arctic regions, the inhabitants of Pike's Peak have but two seasons—summer and winter; two months of summer—August and September—and ten long, cold months of winter. The summer season passes quickly. The atmosphere is congenial; the many visitors to the Peak enhance its social life with joy, wonderment, and mirth. During the summer of 1878, upwards of 900 people, in parties from 5 to 30, visited the Peak, among them many ladies. They registered from the four quarters of the globe, and they all expressed admiration and astonishment at the grandeur and sublimity of the wonderful views as seen from the Peak. To behold a sunrise from the Peak is event of a lifetime, and for this purpose visitors often remain over night at the station to be ready to catch the first glimpse of the sun as it appears above the horizon, gilding with its bright rays the mountains, hills, valleys, and plains, to the wonder and delight of the amazed beholder. The summer months are also occupied in preparing for the long siege of winter. During the months of August and September upwards of 3,000lb. of the usual variety of family stores, and about 25 cords of firewood are snugly stowed away. These are all carried to the Peak in small quantities on the back of the poor, despised Burro, whose head has the appearance of being encased in cloth, and whose ears are nearly the length of his legs, and who walks at the pace of a snail, and a very slow snail at that.

Dredging in the Caribbean Sea.—At the recent annual

meeting of the United States National Academy, Professor Agassiz presented an interesting report on dredging operations carried on in the Caribbean Sea during the past year. He had, he said, verified a theory held by him for some time regarding the necessity and utility of deep-sea dredging — that almost all the fauna found at the greatest depths by the *Challenger* expedition are also to be found at a depth of not more than 2,500 fathoms. The work of the *Challenger* had been confined to dredging at great depths, and occupied about two-and-a-half years; while he, on a small steamer of 350 tons, had been able in a few months to make a collection of deep-sea fauna second only to that of the *Challenger* expedition, and approaching near to it in completeness and variety. Professor Agassiz also discussed the question of a sunken continent, once occupying a great share of the area of the present Caribbean Sea, and connecting the West India islands with the coast of Central and South America. He further offered some novel views regarding the flow of the Gulf Stream and its causes.

Europe to Siberia by Water.—At a meeting of the Russian Geographical Society, in the close of 1878, Admiral Krusenstern described the results of his journey to Siberia in 1876 to investigate the possibility of connecting the basin of the Petchora with that of the Ob, and thus open the continuous water-way from Europe to Siberia. He reports favourably on the practicability of the scheme. The scientific results of the journey were topographical surveys, levellings of the principal parts of the route, a whole series of astronomical determinations, and a large addition to our knowledge of a region still little known.

The Upper Course of the Brahmaputra River.—Mr. C. Black read a paper, at the meeting of the British Association, on the upper course of the Sanpu, or Brahmaputra River, with special reference to an important exploration recently made by a native surveyor, attached to the Indian Survey Department. After giving a general description of the geography of the upper portion of the Sanpu as derived from Messrs. Bogle, Manning, and recent travellers, Mr. Black proceeded to describe the new survey, which commenced east of Chetang, a village in Eastern Tibet. Previous explorers had reported that the course of the river east of that point was first east and then south-east. This proved to be only partly true, as the Sanpu proved to make a huge bend to the northward before entering on its south-western course towards Assam. Various towns and monasteries lay dotted about the valley, some of which were curiously identified by the author with names on D'Anville's map, prepared in the early part of last century. This bend was previously quite unknown, and now leaves room for a northern feeder of the Subansiri, thus accounting satisfactorily for its large bulk, a fact which hitherto had proved somewhat of a puzzle to geographers. Mr. Black concluded by citing some interesting corroborations of this new discovery

afforded by information collected by the Abbé Desgodins, and by Lieutenant Harman's recent measurements of the discharges of the larger rivers of Assam.

Scenes in Afghanistan.—Major Campbell, at the meeting of the British Association, described the Shorawak valley and the Toba plateau in Afghanistan. The Shorawak valley had never been visited by Europeans before the recent campaign. It is a narrow strip of flat country lying between the desert on the west and north-west and a range generally known as the Sarlat Hills to the east. Its total length is about 40 miles, with a width of ten miles at the northern end, and it is 3,250ft. above the sea. The head of the valley to the north is closed in by the southern spurs of the Khwaja-Amran range of mountains, which nearly join the north-western spurs of the Sarlat Hills, only leaving a gap of about a mile through which the Lora River runs into the valley. The desert, which stretches away westward as far as the Persian frontier, rolls up in the form of sand hills to the edge of the cultivated land of the valley. The Lora River, which waters the valley, runs nearly dry in summer, and its water is always brackish. The valley is thickly populated and crops of wheat and barley are raised. The river, after flowing through the valley, is swallowed up in the sand of the desert. The Toba table-land is at the north-eastern extremity of the Khwaja-Amran range of mountains. The general elevation is over 7,000ft. Major Campbell gave an interesting account of this plateau and of its inhabitants. It will probably form an excellent hill sanatorium for the troops stationed in the Pishin Valley. The climate of the plateau in summer is very pleasant.

The Kitchen Middens of Hissarlik.—Dr. L. Moss, R.N., at the meeting of the British Association, exhibited a collection of organic remains from the Kitchen Middens of Hissarlik. He remarked that whatever opinions may be held as to the site or even as to the actual existence of Heroic Troy, there could be no question about the antiquity of the walled acropolis recently unearthed by Dr. Schliemann at that "stepping-off place between Asia and Europe," and on the very spot where tradition placed the ancient stronghold. Dr. Schliemann had most freely given him permission to collect any of the fragments of bones which were exposed in every yard of the excavations, but the accumulations cut through are so extensive and of so many successive ages that he had found it necessary to restrict himself to those immediately overlaying the old wall. They consisted of charred and broken bones of deer, goat, sheep, ox, boar, often marked by sharp cutting instruments, sometimes converted into implements, such as a much-worn handle, exhibited, made from the tibia of a deer. Worn and polished astragali were common, and may have been used in the well-known children's game. The collection also contained the tibia of a teal, and the leg and wing bones of a wader; the vertebræ of a very large and of a small osseous fish, and also vertebræ and palate teeth of a ray.

Molluscan remains were very plentiful, and consisted almost entirely of shells of the edible mollusca, now used everywhere on the shores of the Ægean—namely, cockle, oyster, mussel, limpet, whelk, pecten, solen, and, in one instance petunculus. Parts of trochus and and a bored collumbella may have been used for ornament. Many of the bones of pig were from young animals—a fact that pointed towards domestication. It was remarkable that the antlers of red deer often had the tip of the brow tine sawn off. They were usually cast antlers, or at all events knocked off close to the casting time. The only human bones he saw were those of an unborn infant of about six months, enclosed with a lot of utterly unrecognizable calcined bones in an earthen pot. Among vegetable remains the silicious epidermis of large reeds used to line the plaster on the walls of houses should be noticed. In some places there were considerable masses of carbonized wood. Carbonized peas or lentils were occasionally found in earthen plates or pots. All the remains occurred among quantities of rude potsherds and *débris* of rough stone and brick walls, some of the latter vitrified, as if they had formed the floor or sides of a furnace. Dr. Schliemann's half of the worked gold found in the same layer has been generously deposited in South Kensington; the other half formed the perquisite of the Turkish Government.

The Remains of Buildings in Midian.—Captain Burton delivered a lecture during the early part of 1879 to the Institute of British Architects on "Remains of Buildings in Midian," and stated, among geographical particulars, that Arz Madyan, as the country is called by natives, has a coast-line of about 300 miles on the eastern side of the Red Sea; and that, "topographically speaking, the whole tract is a prolongation of the great Hauranic Valley of the land of Moab; of the Nejeb, or south country; of Idumæa, which the Hebrews called Edom; and of the classical Nabathæa, whose western capital was Petra, the Rock." Traces still exist of an ancient road which, passing eighteen cities and towns, was one of the earliest, if not the very earliest, of "overland routes" to and from India. "Here," says Captain Burton, "before the Nile route to Alexandria was opened, merchants disembarked their goods, preferring the long and toilsome camel-journey to the dangerous ship-voyage northwards; and, reaching Petra, the imports were passed on to Phœnicia and Egypt."

Building materials were abundant, stone of different kinds, alabaster, gypsum, and fireclay, and were turned to good account by the architects and builders of Midian, as is testified by the numerous ruins of houses, temples, tombs, aqueducts, and mining and smelting works. At one of the sea-side settlements the aqueduct was three miles in length; Shuwák, we are told, is a place that "could hardly have lodged less than 20,000 people;" and this is but a section of a once inhabited district through which can be traced "a water-course for the total of at least four miles."

Desolation now prevails in this

onçe populous and busy mining country. But the copper and the lead and the gold are not yet exhausted; and it may be that modern enterprise will find scope for its energies in the ancient land of Midian.

Buddhist Remains in the Jellalabad Region.—Mr. W. Simpson read a paper at the meeting of the British Association, on Buddhist remains, which he traced in the Jellalabad region. He gave a list of the larger groups. One point, he said, was apparently clear, that in the Buddhist period the population of the Jellalabad Valley must have been much more numerous than at present, and that the area of cultivation must have been also more extensive. The topes were large and elaborate architectural structures, and the author believes the same might be said of the monasteries; for the explorations produced sculptures and plaster figures in great quantities, which had been all painted with bright colours, and in many cases thickly gilt. The wealth necessary to construct such a mass of buildings, as well as the maintenance of them, and the large population of monks who lived in these places, must have been great. The scanty number of people in the region at this day would be quite insufficient to support them. The Buddhist ascetics alone must have been, judging by the remains, two or three times greater than the present population.

At Girdi Kas, where the river flows out of the valley at the eastern end, are the remains of an aqueduct and an old road. The last is known as the Badshah-i-Rah, or the "Imperial road," and it was supposed from its name to have been made by one of the Emperors of India. Our engineers made repairs on this road, and from the officers engaged on this work Mr. Simpson received the information that portions of Buddhist masonry are still to be seen on it, showing it is older than the Badshahs who ruled in Delhi, and that regularly-constructed ways were made in the more civilized period of Buddhism, a kind of public work which the Afghan has long ceased to trouble himself about. While the engineers were at work at this spot they also discovered an old aqueduct constructed along with the road, with a considerable tunnel through one of the hills, by which the water was led to the Chardeh Plain, on the east of the Jellalabad Valley, and which is now a desert of stones, and so dangerous from the heat that no native of the country, they were told, would venture to pass over it in June or July in the daytime. The aqueduct discovered by the officers is a pretty clear evidence that this wilderness of boulders was at some former period under cultivation.

Further valuable light drawn from the same source was afforded by Major Cavagnari supplying the author with a working party to make excavations at the Ahin Posh Tope, about a mile south from Jellalabad. The principal object was to explore the architectural details of the remains, but while thus engaged the author penetrated, by means of a tunnel cut for about 45ft. through solid masonry, to the central cell of

the shrine, and found, along with what were most probably the ashes of some Buddhist saint of high repute, twenty gold coins, each about the size of a sovereign. Seventeen of these were Bactrian, or Indo-Scythian, and three were Roman. One belonged to Domitian, another to Trajan, and the third to "Sabina Augusta," the wife of Hadrian. Evidence of a road has already been given, and these coins prove that at a past date a commerce went along that road; and it must have been a commerce of considerable importance which brought coins all the way from ancient Rome in its track. They knew that in the Buddhist period the capital city of the Jellalabad region was called Nagarahara. When Mr. Simpson started for the Afghan war, Colonel Yule called his attention to this as a point of importance, and that the fixing of its site would be of some value. This task the author thinks he has accomplished.

Referring to efforts to penetrate Kafiristan—all of which had failed—Mr. Simpson said that what was wanted in order to explore this region was for a man to go out and live there, gradually working his way among the tribes. The first thing, however, that was done with a man when he crossed the frontier was to kill him. It was said if the frontier was once crossed the stranger was safe; he was then married to a number of wives, and they took care he did not get away.

A Lost Island.—At a meeting early in 1879 of the Royal Dublin Society, Dr. W. Frazer exhibited a copy of Tassin's maps of the fortified towns of France, which was additionally interesting by its containing several original plans, drawn by Tassin and bird's-eye views of Cazal and Evereux. It also contained a manuscript map of the opposite coasts of France and Britain, apparently of most scrupulous accuracy, and a "Chart of the Islands and Maritime Coasts of Europe, in which is to be seen the route and navigation of the Hollanders by the north of Ireland and Scotland during the wars with the English for the German Ocean." The course is laid down from Holland along the Norwegian coasts, then passes between Fair Island and Foula, inside of "Rockal;" it then continues along the western coast of Ireland, passing Brazil, which is laid down much in the position now ascertained to be occupied by the "Porcupine Bank," and hence the course continues direct to Rochelle. This map is evidently no fanciful sketch. Every sailing point and headland has been skilfully laid down, either by one who has passed over the track itself, or by one who compiled it from most competent authority, and this at a time when no British ships appear to have sailed over these western seas, though we know that the Dutch and French sailors almost daily did so. The probable date of this unpublished and apparently unique work is 1640. This copy appears to be in the very handwriting of Tassin himself, who was geographer to the king, and it would, indeed, appear most probable that Brazil did, as an island, at this, or about this time, hold its head over the waters of the North Atlantic

Ocean, though over its site, and after a lapse of more than two centuries, those very waters, to a depth of from 80 to 100 fathoms, now roll.

It is also of interest to find, as Dr. Frazer points out, that in this map Rockall is represented as consisting of two adjacent islands. As we know, from Sir Wyville Thomson's "Depths of the Sea," but one comparatively small rock now remains with its head over the waters; but there are two banks indicated—one quite a sunken bank, the other that of which the existing rock forms a part. The evidence, then, would be in favour of Brazil having existed as an island off the entrance to Galway Bay in A.D. 1640, or thereabout, and of its having gradually subsided into the bosom of the ocean.

The Mountains of the Northern and Western Frontier of India.—At the Sheffield meeting of the British Association Mr. Trelawny Saunders read a paper on "The Mountains of the Northern and Western Frontier of India." The paper divided the mountains into groups, to each of which distinct limits were assigned. The several parts of the groups were then discussed, for the purpose of assigning definite limits to the nomenclature of each part. The parallelism of the ranges with the axis and base of the mass was next explained, with the view to expose the fallacious assumption of the prevalence of formidable spurs obstructing lateral communication. Various examples of prolonged lateral communication in the mountains were cited. In conclusion, the southern part of the highland, extending along the Arabian Sea and the Persian Gulf, from the plain of the Indus to the plain of Mesopotamia, was referred to, especially with reference to the proper line of the future railway to India. The lowland along this coast was particularly objected to for a railway, on account of its deadly climate, and an atmosphere reeking with intensely hot vapour. A chain of elevated valleys, running parallel to the coast, was traced by way of Shiraz and Kej as a preferable railway route.

By Rail through the Euphrates Valley. — Commander Cameron, R.A., read a paper before the British Association on the Euphrates Valley Railway. He said the question of railway communication with India was a very important one, and therefore it was necessary to judge fairly and dispassionately the advantages which belong to the different routes. He then enumerated the routes and contrasted their advantages and disadvantages. He disapproved of nine of the routes, and as to the tenth, this route would commence at Tripoli, the Mediterranean terminus. There were two good roadsteads at Tripoli, and labour was cheap and abundant. The line he would propose for the railway would follow the country between the mountains and the sea till after passing the Nahr-el-Barid and Nahr-el-Kebir, and then pass through them, by the Wadys Eyne Soodie and Kara Chibok, to the Bukeia, a small and wondrously fertile plain nearly encircled by Nahr-el-Kebir; and after about three miles of rather

difficult work there would be a gradual ascent to the plains around Homo. The route would go on by Mosul by the valley of the Tigris to Bagdad, thence to Bushire, and, in some future time, to Beloochistan and to Kurrachee. In the course of the paper Commander Cameron referred to Cyprus. He said the island would prove of great advantage to the British Crown. It was of great strategical importance, and it was also valuable as showing what, under good government, even with Turkish laws, Asiatic Turkey was capable of. It had been said that Cyprus was unhealthy, and no doubt sickness prevailed among the troops, but it must be remembered they went into tents at the most unfavourable period of the year.

A New Underground Lake.—The Tlemcen *Courier* (Algeria) describes a wonderful discovery recently made at the picturesque cascades of that place. Some miners had blasted an enormous rock near the cascades, and, on removal of the *débris*, found it had covered a large opening into a cave, the floor of which was covered with water. Constructing a rude raft and providing themselves with candles, the workmen sailed along this underground river, which at a distance of 60 mètres was found to merge into a large lake of limpid water. The roof of the cavern was very high and covered with stalactites, the brilliant colours of which sparkled under the light of the candles. Continuing their course, the workmen had at certain places to navigate their craft between the stalactites, which, meeting stalagmites from the bed of the lake, formed enormous columns, which looked as if they had been made expressly to sustain the enormous arches. They thus reached the extremity of the lake, where they noticed a large channel extending towards the south, into which water quietly made its way. This is supposed to be a large fissure which has baffled exploration hitherto at Sebdon, and which connects the cascades with that locality, and thus with the mysterious sources of the Tafna. It is possible that here they have found an immense natural basin, supplied by powerful sources, and sending a part of its waters towards the lake, while the rest goes to Sebdon. The workmen estimated the distance underground traversed by them at three kilomètres and the breadth of the lake at two. They brought out with them a quantity of fish, which swarmed round the raft, and which were found to be blind.

Exploration in Africa.—MM. Savargnan de Brazza and Dr. Ballay returned to Paris during the course of the year after three years' hard work in the exploration of the river Ogowé, in Western Africa. The expedition, of which Lieutenant de Brazza was the leader, had the co-operation at first of M. Marche, who, in company with the late Marquis de Compiègne, had already done much to advance our knowledge of the Ogowé. M. Marche had, however, on account of his health, to give up his work and return to France. MM. de Brazza and Ballay also suffered much from fever at first, and were indeed

suffering when, in August, 1875, they left Lambarene, the extreme limit of the European factories, to commence the real work of their campaign.

For escort they had a dozen Laptots, indigenous soldiers from the French colony of Senegal. The explorers met with many difficulties and discouragements from the hostility and cupidity of the natives, and in the end it became almost a regular series of battles. The course of the Ogowé may be divided into three nearly equal parts—the upper, the middle, and the lower. The middle follows an almost straight east and west course just south of the Equator; the two others incline about a degree and a half towards the south—the one towards its source, the other towards its mouth. The merchandise and baggage of the explorers could only be carried in canoes and by the arms of the natives, who made terrible exactions from the expedition, which was almost entirely in their power.

The first halt was made at Lopé, a large village on the upper course of the Ogowé. M. de Brazza penetrated into the country of the Fans, those fine cannibals whose praises are sung by Burton, with whom he was able to enter into friendly relations; and he succeeded in reaching Dumé, a position considerably advanced on the upper course of the river. M. de Brazza suffered seriously in this journey, and on his return had to let his companions advance to Dumé without him; he was only able to rejoin them in April, 1877.

The further progress of the expedition was almost stopped by the Adumas, who, on the pretext that the whites had introduced the smallpox, wanted to mulct the expedition of the greater part of its baggage. It was only by a ruse that the explorers were able to get out of the clutches of the Adumas, and after many dangers from the numerous rapids the party found themselves together again at the fall of Poubara. Above this the Ogowé becomes an insignificant stream. Here the exploration might have ended, as one object of the expedition had been accomplished—viz., the solution of the question as to whether the Ogowé rose in any great interior lake; it was clear it did not. However, after a few days' rest the explorers, in spite of their broken-down condition and the exhaustion of their resources, left the basin of the Ogowé in March, 1878, to penetrate still further into the interior. So badly did the natives treat them here that they were compelled to buy four slaves to carry the baggage.

Under these circumstances they traversed successively the territories of the Ondumbo, the Umbeté, and the Bateké, suffering greatly by the way from both hunger and thirst, for the country was devastated by famine. A stream, the N'Gambo, running east, led the explorers to an important river, the Alima, which they have made known to geography for the first time. This river, about 500 feet wide and 16 feet deep, to all appearance is an affluent of the Congo. In attempting to descend this river the French explorers had to run the gauntlet between banks lined

with hostile savages, and, like Stanley, were at last compelled to fire in self-defence. Great villages were seen, filled with enemies, who finally attacked the explorers with canoes filled with men armed with guns. They quitted the river and marched northwards, crossing many water-courses flowing eastwards. They suffered so much from hunger that the expedition had to be divided, Dr. Ballay and some of the attendants being sent back to the Ogowé. M. de Brazza went some distance further northwards, when he also from hunger and suffering was compelled to retreat. He rejoined his companions in September, and on November 30 the whole party reached the French settlement at the Gaboon. Thus ended one of the most successful of recent French exploring expeditions. It has added a considerable region hitherto unknown to our maps, and helped not a little to solve the perplexing problem of African hydrography.

The Imperial Survey of India.—A paper on the Imperial Survey of India, by Mr. J. O. N. James, Deputy-Superintendent of the Surveys of India, was read before the British Association by Mr. Black. The object of Mr. James's paper was to sketch out in a concise manner the nature of the work in progress and already performed by the Indian Survey Department, and to point out its practical utility. The Imperial Survey of India, up to a late period, consisted of three distinct branches, namely, the Trigonometrical, Topographical, and Revenue Surveys. The Trigonometrical Survey, besides its purely scientific work, furnishes the great basis by principal triangulation for the origin and extension of detail surveys executed by the Topographical and Revenue branches. Already the whole of India is covered with principal triangulation which, for scientific accuracy, is unsurpassed by any similar undertaking in the world. To the Topographical branch is assigned the labour of executing geographical surveys of native states and hilly or forest tracts in British territory, usually on a scale of one inch to the mile. Mr. James described the methods adopted in the execution of these topographical surveys, and pointed out the vast amount of geographical information which is collected by the surveyors.

During the administration of Sir Henry Thuillier, late Surveyor-General of India (1861 to 1877), an area of not less than 290,000 square miles was surveyed and mapped, including the wildest and least-known tracts of India. This enormous area, more than double the size of Great Britain and Ireland, was surveyed in 16 years at an average cost of £2 the square mile. The Revenue Survey operations, the paper said, are chiefly confined to open and well-cultivated districts in British territory. They furnish complete and accurate records of the area and boundaries of every village and district. They show the extent of waste and cultivated land, the nature of the soil, and the principal features of the country on a scale of four inches to the mile. From these original surveys excellent maps of complete

districts are completed on various scales for general administrative purposes. In some special districts the system of cadastral field surveys has been introduced.

During Sir Henry Thuillier's superintendence (from 1847 to 1877) an area of 493,000 square miles was completed on the village survey system, on a scale of four inches to the mile, and 12,281 square miles by cadastral measurement, on a scale of 16 and 32 inches to the mile, making an aggregate of 505,574 square miles, considerably more than double the area of France. The Revenue Surveys comprise a great portion of Bengal and Assam, all Oude, part of the North-West and Central Provinces and Bombay, nearly all the Punjab, and all Scinde. This work has not been accomplished without the sacrifice of many valuable lives, and the necessity of facing dangers and hardships of no common kind. The zeal and devotion of the Indian surveyors are beyond all praise, and their work has been and continues to be most valuable.

It must, however, be clearly understood that a considerable portion of what has been accomplished by the Topographical branch of the Department is nothing more than a first survey, rapidly executed, for geographical and general administrative purposes. Hereafter more rigorously accurate and complete surveys will be needed. Meanwhile, there is not a single official in India who does not possess maps of the portion of the country included in his jurisdiction which are suited to every present requirement. The maps issued by the Surveyor-General's Department are also utilised by engineers in the construction of public works, by the foresters for conservancy purposes, by mining companies, planters, holders of estates, and by every branch of the civil and military services for purposes too numerous to detail.

The Unsurveyed Coasts of the World.—A paper was read before the British Association by Lieutenant Temple, R.N., dealing with the unsurveyed coasts of the world. He reminded the section that public attention had been lately drawn to the unsurveyed state of parts of the coast of South Africa, and to the fact that they had not been sounded for half a century, by the grounding of Her Majesty's ships *Active* and *Tenedos* on some unknown reefs. Inquiry was thus directed into the present state of the surveying branch of the Navy, with a view to the prevention of similar disasters in the future. Instead of progressing, or even maintaining its position, the surveying service had been allowed to decline, and by the middle of 1873 it had fallen so low that only one of Her Majesty's ships was engaged in actual surveying duties. As regards home work, the Hydrographical Department was unequal to the demands upon it. At the present time there were five regular surveying ships in commission, while detached parties were doing their best with small craft and hired steamers, or with hired boats and crews. The detached system of nautical surveying, though undoubtedly cheap, and of some value as an auxiliary force, had several disadvantages

An enormous amount of work remained to be done in the examination and charting of the seaboard in various parts of the world.

Attention was specially called to the West Indies, the east and west coasts of South America, the Pacific coast of Central America, the Sandwich Islands, Fiji Islands, New Zealand, Tasmania, Australian Colonies, the routes between Australia and China or Japan, the China Seas, the coasts of China or Japan, the west coast of the peninsula of Siam, the east and west coasts of Southern Africa (including the Cape Colony), the inner channels of the Red Sea, and several parts of the Mediterranean.

Lieutenant Temple earnestly appealed for the restoration of the Surveying Service to the prominent position it ought to hold among the forces of civilisation, and for its protection in some measure from the restraint of an ill-judged economy. The paper concluded with the expression of a hope that before long the commander-in-chief of every station would have a properly equipped surveying ship at his disposal, and that the Hydrographical Department might be extended, to enable it to keep pace with the wants of the times, and to publish and circulate its stores of information.

Arctic Research.—Commander L. A. Beaumont, R.N., read a paper at the Sheffield meeting of the British Association, on "Arctic Research." The author said he had no new theory to offer to the section to take the public by storm. He held that the future of arctic work must depend upon the persevering efforts and reasonable arguments of those who advocate it, and that the revival of interest in arctic exploration will commence amongst those who are sure to be more influenced by valuable and substantial results as an object than by the prospect of a brilliant but profitless achievement. In spite of the unfortunate controversies which followed the return of the late Arctic Expedition, the discovery of the unknown will never be permanently abandoned, and the arctic regions, in common with the rest of the world, will surely be discovered and explored.

As regards the alleged risks and dangers, the author asked why they should exercise a deterrent effect, any more than the perils and dangers of African or Australian travel. There will always be men ready to go, and in due time there will be sufficient support forthcoming to provide the means. On the east coast of Greenland, and beyond Robeson Strait, there is heavy ice similar to that met with by M'Clure and Collinson, and afterwards by Meahan and M'Clintock, along the coast of North America and adjacent islands; and whenever it occurs ship navigation entirely ceases, while the difficulty of sledge travelling is immensely increased. It would seem that in all future work this sort of ice must be reckoned upon; and that no ship will ever get much beyond 82° north. In sledge travelling it is indispensable that land should be near, and that the ice should be fast, and there are few known points where these conditions can be obtained. Nevertheless, Commander Beaumont contended that there was nothing

discouraging in this; nor need the work be confined to the highest latitudes, for where scientific research and a practical school for future explorers are the objects, much important work can be done in all parts of the unknown region. He anticipated a rich harvest of valuable results from the work of the present year.

The author then addressed himself to the question of which route affords the best promise of geographical discovery. Franz-Joseph Land seems, at first sight, to fulfil the conditions required to insure success. Here the land extends far to the north, and if any part of the shore could be reached by a ship, a sledging party might certainly attain to the 86th parallel. But the disadvantages of the route were, that it is uncertain whether a vessel could reach the land, while there was no alternative after starting but to succeed or fail. If the main object was not gained, no lesser useful work can be done.

The next route, in Commander Beaumont's opinion, now that the North-East Passage had been achieved, was the exploration of the land about Cape Britannia, proceeding by way of Smith Sound—that is, the discovery of the northern side of Greenland. He preferred this route to an attempt along the eastern side, because a higher latitude can be reached by Smith Sound; and he believed that a vessel might winter on the eastern shore of Robeson Strait and advance depôts to Repulse Harbour in the autumn. Commander Beaumont, who has seen Cape Britannia, the most northern known point of Greenland, believes that to stand on its highest peak would alone throw much light on Greenland geography. He then submitted calculations, derived from his own experience, of the time that it would take for a sledge party to reach Cape Britannia, and of the nature of the ice; and offered several valuable suggestions for improved appliances in travelling over soft and deep snow. Commander Beaumont confidently predicted important geographical discoveries and other useful scientific results for an Arctic expedition despatched up Smith Sound, with Cape Britannia and coasts beyond as its principal goal.

In Afghanistan.—At the Sheffield meeting of the British Association a paper was read, written from Candahar by Captain R. Beavan. In it he described the country between Candahar and Girishk, which was traversed by the division under the command of Major-General Biddulph in January and February, 1879. Girishk, on the right bank of the river Halmand, is of great importance as a military position, because it lies at the extremity of the vast mountain masses that break up the whole country between the Halmand and the Arghastan into a troubled sea of rock. Skirting the route to the south lies the great sandy desert, equally impassable for troops. Thus the tract from Girishk to Candahar forms practically the sole military passage between India on the one hand, and Persia or Turkestan on the other. It is for armies what the Suez Canal is for ships. The narrow strip of plain which this route traverses

forms the interval between the desert and the hilly country. The desert rolls up in undulating sand-hills from the far south. It is bounded by the rivers Arghanda and Dori, the thin lines of running water seeming as if they had some magic influence in restraining the overflow of the sand. To the north are the mountains, bare and rugged, not a sign of verdure anywhere about them, not an indication of moisture.

The great peculiarity of the country is, that only the upper portions of the hills are exposed above ground. The whole country, including the lateral valleys, appears to have been filled up at a date subsequent to the elevation of the hills with a deposit of rubble, water-worn boulders, and pebbles, with hardly sufficient soil to hold them together. The elevation of this part of the country is over 3,000ft. above the sea. This deposit, though apparently level, in reality slopes considerably upwards from the rivers to the base of the hills, while the valleys have a slope in the direction of their length.

Captain Beavan then explained how this formation aided the peculiar system of irrigation by means of *karez*, or underground aqueducts, which is constantly made use of in this part of Afghanistan. At the junction of the two rivers Halmand and Arghanda, and from this point along the banks of the Halmand to a considerable distance above Girishk, are scattered the remains of numerous forts and intrenchments, showing the importance that has always attached to this part of the Halmand River. Girishk itself is simply a fort, commanding the Herat road. There is no town near it, but the whole of the Halmand Valley is full of small, scattered villages, with gardens, trees, and fields. To the north-west from Girishk, by the Herat road, the country is mountainous, and again towards the north-east, but in a northerly direction it appears quite open and level as far as the eye can see. The only exception is that, on very clear mornings after rain, a few snowy peaks are visible, just showing their tops above the horizon. Captain Beavan found the old position of Girishk fairly correct, and he ascertained the heights of the camping-grounds along the route from Candahar to Girishk by aneroid and boiling point.

New Routes to Candahar.—At the Sheffield Meeting of the British Association, Captain Holdich described some new routes to Candahar. In weighing the capabilities of the various passes now known to exist in the mountain barrier of Western and North-Western India, with the important political and strategical object of selecting the best main route to Candahar, the author commenced by stating his objections to those in use at present. Admitting that Kurrachee may prove the best base for communication with our frontier posts as they stand at present at Quetta and Pishin, he considered that the direct Sonmeeani route, connecting the coast with Biela, Khelat, and Quetta, though passing through a friendly country, would be too great a burden to maintain, as it traverses a wild, unproductive, and most unpromising region. The

Jacobabad-Bolan route, on the western side of the Indus, is also open to the periodical danger of inundation by that river (resulting last year in the isolation of Jacobabad itself from Sukkur by thirty-eight miles of water), and to the restriction of its use to cold weather, owing to the painful and disastrous effects of crossing the Kachi desert in the hot season.

The journeys, however, of the native explorers, instructed by Colonel Browne, through the previously unknown district lying between the Quetta-Pishin line and the Suliman range, have resulted in the accumulation of material sufficient to warrant the march of a column under General Biddulph from Candahar, eastwards, towards Dera Ghazi Khan, which has been selected as the base on the Indian side on account of its proximity to Mooltan, on the Indus Valley Railway, and its avoiding a desert passage to the hills. The object of this march was to investigate the various practicable caravan and other routes said to exist between the Pishin Valley and Dera Ghazi. Starting from Kushdil Khan, at the eastern end of the Pishin Valley, this expedition reached Bolozai, to the Surkhab Valley, by crossing the Suranari Pass, and here were discovered two great rivers, the Zhob and Bhori, radiating eastward through open valleys, and affording the finest openings for a route to India. The Zhob, which trended too much northwards, was not followed, but apparently would strike the frontier ranges at the Gulere (or Gomul) Pass.

The Bhori Valley was reached from Bolozai by following the bed of the Surkhab River by Yusuf Kutch to the Ushtara Pass (a wide and convenient one), the sandstone hills culminating at Mashkwar in grand and vividly-coloured scenery, contrasting strongly with the usually tame aspect of the Candahar region. Thence, from Chimjan through the Bhori Valley to Anumbar, the road recalled the Lombardy plains. Part of the expedition turned southward at Katz, *viâ* Smalan and Baghao, with the intent of exploring the Thall and Chotiali route; but the main party kept the straight road, following the river to Anumbar, and reached the Chimalang Valley by the Treek Kuram Pass, whence they struck south among winding precipitous ranges to Baladaka, eventually arriving, by the Han Pass and Hasni Kot, in the valley of Lugari Barkan. This valley is open to the Kaho Pass by Vitakari, and reaches the Derajat plain about forty miles south of Dera Ghazi.

All this road is capable of easily carrying a railway, and as it now is will exist for ever. It could be shortened by not striking south at the Treet Kuram Pass, but keeping eastward and south-eastward on the Karwaddi route, *viâ* Rakni, to the Fort Monro or Sakki Sarwar Passes, opening opposite Dera Ghazi. The party that followed the Thall and Chotiali route also reached the Lugari Barkan Valley, but no good direct route could be found between Thall and Vitakari, which is a desirable position at the head of the Chachar Pass. The chief addition to our knowledge from this

expedition was that the hitherto unknown region between the Pishin Valley and the Suliman Range was found to be open, rich, and fertile, with nothing in its physical character preventing travel across it in almost any direction.

Travels in Africa.—A paper by Major Servia Pinto, on his exploration in Africa, was read before the British Association, at their Sheffield meeting (*see also* p. 6). The writer said the subject he had to discuss was the geography of Southern Africa, and the difficulty of his task was increased by the fact that he had been preceded by men of such eminence as Cameron, Livingstone, Grant, Burton, and many others who were not less worthy of personal homage and the admiration of the world.

He wished to say a few words with regard to the important part of Africa which belongs to Portugal. Portugal, after making great efforts in discovery, stopped on her way. After the death of Lacerda, who was the first to determine the strictly correct latitudes in the interior of Southern Africa, many years elapsed without any similar enterprise. He then glanced at the labours of explorers in the latter part of the last and the early part of the present century, and dwelt on the great efforts of Cameron. In Portugal the task of developing and civilizing Africa was warmly patronised by the king, and supported by the people.

As to his own journey, putting aside details as to privations and sufferings, the first question on which he intended to speak was the system of carrying out geographical studies in great enterprises, and the second question was the basin of the Upper Zambesi, a country as to which many erroneous ideas were prevalent.

The instrument he used was the sextant, but he also used the aba. It happened to him once when in the Upper Zambesi that he had made up his mind to determine the latitude of the Gonhah cataract. The moon was expected to pass the meridian at 2 p.m., and he felt sure he would be able to determine his latitude. It was half-past one when he was startled by a great noise in his encampment, and he ran thither at once. A quarrel had arisen between his men from the West Coast and the Makalaka oarsmen, and but for his prompt interference the dispute might have had a serious ending. He seized his sextant and proceeded to take the observation. The moon had already passed the meridian, and was rapidly descending towards the horizon. He felt desperate, and if he had had an altazimuth he should have been enabled to observe the sun in its meridian passage, which he could not perform with the sextant. He then made a series of sun-lunar distances, and by the bare distance he made out the latitude.

He spoke highly of the aba, and then went on to say:—The exploring movement in Africa is far from being at an end; rather, we may say, it is in its infancy. Thus it was the duty of those who, like themselves, had any interest in the movement, to endeavour to supply future historians with the means of obtaining, with the

greatest ease, the most reliable information and data. He was also desirous of calling the attention of the section to the manner of determining the longitudes by the eclipses of the satellites of Jupiter, and he suggested a means of overcoming an obvious difficulty. Let it be resolved, he said, that in one of the many official observatories that had the support of Europe the eclipses of the satellites of Jupiter be studied without interruption, and the solitary explorer, lost, so to speak, in the enormous solitudes of the dark continent, when he, in the obscurity of night, saw the little brilliant speck disappear, would know that, in a position perfectly determined, some other person likewise, at that same moment, saw the small satellite disappear, and he will have the consciousness that on his return to Europe he will meet with the necessary elements to determine as many strictly correct longitudes as were the observations he might have made. When the planet was in conjunction the telescope might be turned towards the star that hid itself, or by making a series of apozenites of the moon they would obtain their longitudes. Any explorer of tropical Africa once provided with the aba and a telescope of 4ft. focal distance would find himself in a position to determine two of the co-ordinates, and any variations of the compass. Major Pinto further recommended the hypsometer and aneroids for altitudes.

Passing from this branch of his subject, he represented himself as standing on the borders of the Zambesi, "that enormous river, the rival of the Congo and the Nile," the only part of his journey on which he proposed to dilate. This river, the first after the Congo, constituted, notwithstanding its cataracts and shoals, a water-way perfectly navigable in many places and for considerable extents. Most of the countries it traversed were poor, but others were rich, and if many were unhealthy, there were others comparatively good. The Zambesi was bound in future to play a most prominent part in the progress and development of Southern Africa.

It was said that some women increased in love to their husbands the more they were ill-treated by them. It might, perhaps, be that a similar feeling operated upon him with regard to the Zambesi. He was quite a boy when he put his foot for the first time on African soil precisely at the mouth of the Zambesi. No sooner had he landed than a tremendous storm arose, and the vessel which had borne him was compelled to weigh anchor and put to sea. He found himself there, with one companion, thus abandoned on the shore, where for four days they lived solely on crabs, and had much to do to survive on this scanty diet. Thus he commenced his acquaintanceship with the Zambesi. Shortly afterwards an eminent Portuguese physician saved him from death near Senna, where a terrible fever left him but a scanty hold on life. Later on he stood by the Zambesi close to Massangano, and saw its waters tinged with the blood of many of his comrades who fell in the hot encounter on that spot in Novem-

ber, 1869. In the same place, in the previous year, there fell in the battle of Arnanha 2,000 Portuguese subjects. It was thus too true that Portugal had also had her Isandlana in defending rights acquired in Africa, even if they had not been so graphically described as ours. He gave as another reason for attachment to the Zambesi the fact that it was through it the Portuguese made their way into the interior of Africa, and that a building raised in the interior as evidence of progress and civilization was erected by the Portuguese at Zumbel, about 700 miles from the coast of Zambesi. The ruins of a missionary institution were still visible there, and which had been described by Livingstone. In that building had been taught the Gospel, and the rudiments of civilization had been imparted. The Zambesi, in short, was the oldest acquaintance of the Portuguese in Africa, and he supposed it was for that reason he loved it. Livingstone, undoubtedly the most prominent figure among modern African explorers, had nevertheless a decided tendency to be unjust towards Portugal. When Livingstone first went to the Zambesi and discovered its upper course he might as well have stated that he met there at the same time a Portuguese subject, old Silvo Porto. It was only much later on that Livingstone referred to him, simply because he could not avoid it. The Zambesi had been considered a stain upon the fame of Portugal, because it was the emporium of the slave trade; but though some Portuguese were still interested in the retention of that trade, they belonged to the criminal class; and Portugal could no more be held responsible for crimes committed by them than England could be for the actions of those executed at Newgate.

Major Pinto then gave a short *résumé* of the meteorological conditions of the Zambesi. He explained that the banks of the upper part of the river were of a fine and white sand of a remarkable character; when trod upon it produced a queer sound resembling somewhat the crying of a young child. The range of the Catongo mountains was well peopled on the westward, and it was there the Barotzes made their plantations, which consisted of maize, sweet potatoes, pumpkins, and mandisca. The great plain was not availed of for agriculture. Around the lakes and some other places a kind of grass grew, upon which thousands of oxen might be seen grazing. The Luinas followed the calling of shepherds. Horses could very easily be bred there, and the Barotzes possessed a splendid specimen of hounds, with which the natives hunted the antelope.

The human race at present populating the country was a true mixture of Lobares, Luinas, and Janguellis. The Makalotus had now disappeared completely. Polygamy prevailed; and, contrary to what occurred in most other tribes, women who were held to be noble enjoyed high consideration and were sometimes invested with the exercise of public functions. The Barotzes possessed a tolerable quantity of firearms, but their natural arm

was the assegai. They were rather industrious and good tanners, but did not use the knife, doing all their work with the blade of the assegai.

In closing his paper with a few general remarks on Southern Africa, Major Pinto remarked that Portugal and England are the two nations who possess there the most important colonies and have the greatest interests at stake. Each possessing too large a tract of land for either to be jealous of the other's holding, let them, therefore, march hand in hand, each lending support to the other, and let them agree and combine their best efforts towards the great task of developing and civilizing those unclaimed regions. He expressed a hope that the first token of this fraternal union for the development of Africa would be the construction of a railway which would bring into contact the Transvaal and Lourenes Marques.

The North-East Passage Accomplished.—This was undoubtedly the great geographical feat of the year. The honour of being the first to make the passage, many times attempted since the days of the famous Stephen Burrough, belongs to the already distinguished explorer, Professor A. E. Nordenskiöld. The expedition left Gothenburg in the early part of July 1878, and arrived at Yokohama on the 2nd September, 1879. The winter was passed in the ice to the east of Kolinchin Bay in lat. 67° 7′ N., long. 173° 24′ W. It appears to have been spent pleasantly, supplies of fresh meat and fish having been furnished by the Chukchi inhabiting the villages along the coast. Not a single case of scurvy occurred. The cold was intense, averaging −33 F. After an imprisonment of 264 days the *Vega* was enabled to proceed on her homeward voyage on the 18th of July. The East Cape of Asia was doubled on the 20th, and the north-east passage had thus been accomplished. Before proceeding to Japan, Professor Nordenskiöld visited St. Lawrence Bay, Port Clarence, St. Lawrence Island, and Behring Island, where an agent of the Alaska Trading Company furnished him with the first European news he had heard since his departure from Gothenburg. The time passed in the Behring Sea was employed in dredging, more especially in that part of it where the currents of the Arctic and Atlantic Oceans meet. The Professor was fortunate enough to catch a *Rytina stelleri*, a gigantic marine mammal supposed to have been exterminated, and which has not been seen since 1786. He thinks that the passage first navigated by him affords a safe and certain route from Europe to Asia, and he speaks favourably of the trading potentialities of the vast basin drained by the River Lena.

IV.—GEOLOGICAL RECORDS.

How the Alps were Formed.—Mr. J. W. Judd, F.R.S., Professor of Geology at the Royal School of Mines, gave a lecture at the London Institution, in the close of 1878, his subject being the formation of the Swiss Alps. The results of geological observations are, as the lecturer pointed out, that four stages can be recognised in the history of these Alps. First, the existence of a line of weakness in the earth's crust nearly coincident with the line of the present mountains. This is evidenced by the fact that along this line of weakness there were volcanic outbursts, the results of which can still be traced. Secondly, there followed along this line of weakness a depression; and in this huge "trough" of miles in extent there were accumulated sands, limestones, and clays by various forms of water-agencies and by animals living in the waters. Thirdly, there followed the consolidation of these soft and loose materials. There is evidence that the accumulation was of from six to seven miles in thickness, and the mere weight of the superincumbent material on the lower strata would have a share in effecting consolidation. But this was not all. Under this vast covering heat had led to crystallization from fusion. There was, too, the crushing in from the sides of the trough. This was illustrated by a model of the late Sir H. de la Beche, where lateral pressure was employed on layers of different coloured cloth, showing how crumpling resulted, with uplifting of parts of the accumulated mass. Fourthly, there had been the sculpturing of all this into its present form, which was the work of rains and frosts, Some of the existing peaks, even 3,000 feet high, were composed entirely of the disintegrated material resulting from the action of water, either as ice in glaciers, or as rain and streams. The amount of material removed in this way was so stupendous it was almost staggering to try to grasp the facts. The sculpturing of the contours is still going on. This fourth stage was of quite recent date, speaking geologically; but the whole history involved a lapse of time which at the beginning of this century philosophers would not have been prepared to grant, even if this since-acquired knowledge of facts had been presented to them. Professor Judd concluded by pointing out the influence Sir Charles Lyell had had in modifying popular thought on such matters.

Early Types of Insects.—Mr. Scudder, in March, 1879, published, in the "Boston Natural History Memoirs," a paper on the "Origin and Sequence of Insect Life in Palæozoic Times." The first discovery of insect life in the coal measures was made in

1833, and the specimen was found at Coalbrookdale. Since then many have been found in the palæozoic rocks; but they are found but rarely, and probably not over 100 species are known. The three orders of insects—the *hecapods*, the *arachnids*, and the *myriapods*—appeared simultaneously in carboniferous strata of the first order. The higher forms—such as bees, moths, flies—are to be found in the Devonian and carboniferous periods. The lower forms—as the beetles, bugs, and cockroaches—are to be found in the Jurassic period. The Devonian insects were undoubtedly aquatic in early life. Nearly all the *palæozoic orthoptera* belong to the lower families, and were unable to jump as the grasshoppers do; indeed, they are almost exclusively cockroaches. All the earlier types would appear to be of inferior organization. The general type of wing structure in insects has remained unaltered from the earliest times. For the most part, their front and hind wings were alike; they were also large in size, some gigantic; and there is a striking similarity between the carboniferous insect-fauna of Europe and that of North America.

A Geological Discovery.—In connection with the operations of the United States Fish Commission during 1878, *Harper's Weekly* furnishes some particulars of what may be considered as one of the most important discoveries of recent date with regard to the geology of North America. During the operations of the Commission a formation was met with which belongs probably to the Miocene or Later Tertiary, as shown by the occurrence of numerous fragments of eroded, hard, compact, calcareous sandstone and sandy limestone. These are usually perforated by the burrows of *Saxicava rugosa*, and contain, in more or less abundance, fossil shells and fragments of lignite, radiates, &c. These fragments have generally been hauled up by trawl lines from depths of from 50 to 250 fathoms, and have already furnished a large number of species, some of them northern forms still living on the New England coast; others for the most part extinct. A conspicuous fossil, of an undescribed species, belongs to the genus *Isocardia*. Other genera are *Mya*, *Ensatella*, *Cyprina*, *Natica*, *Cardium*, *Cyclocardia*, *Fusus*, *Latirus*, *Turritella*, &c. The specimens so far obtained range from George's Bank to Banquereau, a region of at least several hundred miles in length, and extending along the outer banks from off Newfoundland nearly to Cape Cod. Indeed, it is suggested by Professor Verrill that the formation constitutes in large part the plateaus known as fishing banks, frequented by such large numbers of cod, halibut, &c. The credit of bringing these specimens to light is due chiefly to Mr. Warren Upham, who originally visited Gloucester for the purpose of investigating certain glacial drift and fossiliferous deposits, and who obtained many of the specimens from fishermen who had brought them in and kept them as curiosities.

A Buried Forest.—An interesting geological discovery has been lately announced, which was

made by Dr. Moesta, the Geological Director of Marburg, in the course of some extensive explorations in the neighbourhood of Rotenburg on the Fulda, in Hesse Cassel. From his investigations, Dr. Moesta has come to the conclusion that an oak wood lies buried in that portion of the valley ot the Fulda, at about a depth of from 6ft. to 9ft. below the surface. This wood flourished at a very remote period of the earth's existence. Explorations carried on in the bed of the Fulda have brought to light several of the trees. It is estimated that between 200 and 300 trees are embedded in the river bed between Hersfeld and Melsungen (about 30 miles), which would warrant the expectation that at least ten times that number are to be found in the soil of the adjoining valley. The greater number of the trees discovered were in good preservation; but, owing to the action of the water through unnumbered ages, they have become thoroughly black in colour. They have also become very hard and close, so that they would be excellent material for carving and ornamental cabinet-work. Some of the trees are of great size; one, taken out of a gravelly portion of the bed opposite the village of Baumbach, and since sent to the Geological Museum at Berlin, was 59ft. long, nearly 5ft. in diameter near the root, and about 38in. at the top; so that its solid contents are about 630 cubic feet. Even larger specimens have been found. An interesting question remains to be solved: Do those buried oaks belong to a species still existing, or to an extinct one?

The Age of Sedimentary Rocks.—Mr. J. Mellard Reade, early in 1879, made a communication to the Royal Society on "Limestone as an Index of Geological Time." He believed that analogy leads us to regard the earliest materials as of the nature of granite and basalt. He calculated the average sedimentary thickness at one mile, and that one-tenth of the thickness of this is calcareous. The later strata of England are much more calcareous than the earlier, and this holds good for Europe. This was regarded as indicating an increase in lime available in the formation of sedimentary deposits, and it was pointed out that the annual depth of rain running off the granite and igneous rock areas is averaged at 28 inches, and the annual contributions of lime in the forms of carbonates and sulphates is 70 tons per square mile. From this Mr. Reade has calculated that the elimination of calcareous matter contained in the sedimentary crust of the earth must have occupied at least 600,000,000 years.

The Age of the Penine Chain.—In the Geological section of the British Association, Mr. E. Wilson read a paper on "The Age of the Penine Chain," in which he combated the generally-accepted view of the post-Permian origin of the chain and contended for a pre-Permian upheaval. In support of this opinion the following facts were cited:—The Yorkshire coal-basin was admittedly pre-Permian, for north of Nottingham the magnesian limestone everywhere overlapped the coal measures; but the axis of this

basin was parallel with and was evidently determined by the same series of movements that upraised the Penine chain. The Permians disappeared on the west in approaching the Penine chain; in this direction also the marl slates attenuated, and the marl slates and magnesian limestone became more sedimentary, as if approaching a margin. Mountain limestone pebbles occurred in Permian breccias on one or both sides of the Penine axis. Many fragments of carboniferous rocks occur in lower bunter sandstone (breccias) on the borders of Notts and Derbyshire; but Mr. Wilson said he found no fragments of Permian rocks in these breccias. No outliers of Permian rocks were discovered at any distance west of the magnesian limestone escarpment between Nottingham and Northumberland. The character and succession of the Permians on the two sides of the Penine chain were very dissimilar.

Notes on Limestone.—A paper was read at the Sheffield meeting of the British Association, by Dr. J. Phené, on "The Deposit of Carbonate of Lime at Hierapolis, in Anatolia, and the Efflorescence of the Limestone at Les Baux, in Provence." The author said he had selected these two distant sites of calcareous deposit, not alone from their picturesque beauty and effect, but because they presented, he believed, the most widely differing conditions of a somewhat similar material probably to be found. In the former case, the deposit of lime was so rapid that a large extent of country was covered with it. Its forms were eccentric and yet so beautiful that there was hardly any style of ornament the simulation of which would not be found in it. The Roman city, which took the place of a former Grecian one, was half submerged beneath a sea of rock of intense hardness, which, blocking up streets, temples, and vast arches, after reaching to a certain height, the level of its source, ran over the natural aqueducts which it formed as it went, and began new ones lower down, which it again and again, as it reached the level of its source, repeated. Part of the deposit was perfectly white, the other part quite black, giving the most singular appearance, as it looked like a snow-drift lying in the intensely hot sun of Asia Minor, or a cataract of snow falling over black rocks, or a frozen cascade, which could only be illustrated in drawing by giving a representation in black and white, while the other parts of the landscape were in their usual natural colours. The Turks called it Pambuk Kelessi, or Castle of Cotton, from its whiteness. The hardness of this deposit, and the rapidity of its formation, contrasted strangely with the stone at Les Baux, which, though by no means soft to cut, had from its natural cavities suggested the idea to the founders of the city of excavating their houses in the sides of the rocks quite as much as they built them outwards. This rock, with little or no warning, disintegrated and discharged itself in efflorescence in the air, producing an effect as destructive to the city built there as in the former case, with quite as picturesque an effect, though from an exactly opposite cause. So much was being done now in ascertain-

ing the component parts of stone for the purpose of hardening, as in the recent experiments on the Houses of Parliament, Cleopatra's Needle, and other well-known works, that it occurred to him that an analysis of these two rocks of similar component parts, but with varying conditions, would be well worth the attention of the chemist and the practical constructor.

The Antiquity of Man.—Prof. Boyd Dawkins, in the course of an address delivered before the British Association, on "The Antiquity of Man," said he presented a diagram showing the divisions of the Tertiary period, the third of the three great life periods which had been presented on the earth. When he examined those stages before the highest forms of life, he was confronted with this most important fact: in the eocene age they had not a single species of placental mammal, nor did they meet with any indications of a living placental genus. No species now found in Europe were found in the eocene age. It was absolutely impossible to suppose that man was living on the earth in the eocene time; yet there was no reason, because of climate and vegetation, that he should not have been.

Then they came to the miocene age, when they found not merely living families and orders, but living genera. Putting man out of the question, there was not a single well-authenticated case on record in any part of the world of any mammalian species now living on the earth having lived in the miocene age. The French preserved a flint flake which was found at Thenay, and which they say is of the miocene age; in fact, it was accepted by a great majority of French archæologists that man was living in the miocene age. The French held that flints found, and all of them bearing traces of manufacture, were of the miocene age, and the work of man. It was far less difficult to believe that these flints were the work of some of the higher and extinct forms of monkeys, than it was to believe that they were the work of man.

In the pleiocene age they found one or two living species making their appearance. Professor Capilini had called attention to the fact that certain cut bones, which were asserted to be of the miocene age, had been cut by the hand of man. On one of those bones there were cuts which were done by the hand of man. The cuts were distinctly artificial, but the difficulty which presented itself to his mind was this: he was by no means certain that those cut bones, which were said to have been found in the pleiocene strata, had been discovered in undisturbed pleiocene strata. It was not clear to his mind that the mineralisation of those bones would not take place long after the pleiocene age had passed away. He urged his objections to the accepting of specimens said to have been got in the pleiocene age when there was no good authority for saying that such was the case.

He then passed to the pleistocene, by some called the glacial period. Then living species were very abundant, extinct species very rare, and it was in that age that they met with man in considerable abundance and scattered

over a very wide area. The evidence presented from time to time, in the first place out of caverns, and, on the other hand, out of river deposits, showed beyond a doubt that man was present in Europe in full force in the pleistocene age. and he came in just when it might be expected he would come in.

In the pleistocene age they met with man as a mere hunter, not as a farmer or possessor of wild animals. He mentioned that because during the last two or three years it had been asserted that man was possessed of domestic animals in the pleistocene period.

The prehistoric period, which succeeded the pleistocene, was characterised by the absence of the extinct species of mammalia, with one exception. The one extinct animal which extended upward into the prehistoric age was the Irish elk. The great characteristic of the prehistoric age was the calling in of the domestic animals—the dog, sheep, horse, various breeds of hog, cattle—all coming in under the care of man, all spreading over Europe; and along with them they had the getting of cereals and fruits, and the cultivation of the art of agriculture. They had in that period just those very things which formed the foundation of that civilisation which they themselves spread, and which had been built upon the foundations of the neolithic age. The prehistoric period was divided into the neolithic, the bronze age, and the age of iron. The prehistoric age was divided from the historic, because the former was not represented to them in historic records.

In conclusion, he ventured to express an opinion as to how happy they would be if they could get hold of a date and fix the antiquity of man in Europe in terms of years. It would be most delightful if they could fix the first presence of man at Cresswell Crags, say within some thousands or hundreds of thousands of years. He could not help thinking that all their hopes of that description would be vain, as there were intervals, and they could not know, without the written record, the duration of the intervals which separated one period from another.

V.—METEOROLOGY.

The Nature, Methods, and General Objects of Meteorology. —Mr. R. H. Scott lectured before the Meteorological Society on "The Nature, Methods, and General Objects of Meteorology," on Thursday, December 5, 1878. He commenced by saying that everyone must be interested in meteorology, but the difficulties which are found in making it an exact science are too fatal. Firstly, we have no access to the upper regions of the atmosphere; and, secondly, the observations at each station are affected, to a puzzling extent, by local conditions. In this respect meteorology is at a great disadvantage compared with astronomy. He then spoke of the importance of multiplying stations, provided quality was not sacrificed to quantity, and stated that the great difficulty found in discovering laws of periodicity arose from the fact that few observations could show continuous seconds for even fifty years.

The next subject of the lecture was the mode of collecting information for marine meteorology, and the great complexity of the problems presented to the inquirers in this branch owing to the motion of the ships, and to their being confined to special tracks, instead of being equally distributed over the ocean. A few minutes were then spent in describing the mode of collecting information for telegraphic reports and synoptic work; and regret was expressed that Weyprecht's proposal for international polar observations did not show much prospect of being carried out.

As to methods, Mr. Scott pointed out that at present there are considerable differences between the equipment of stations and the hours of observation in different countries; but that any attempt to enforce uniformity would be sure to meet with opposition. Accordingly, agreement in very minute particulars is hardly to be looked for in comparing returns from foreign stations. As regards results, the isabnormal charts of Dove were exhibited and explained, as well as a general rain chart of the globe; but it was pointed out how desirable it would be to have twelve rain-charts, so as to show the monthly distribution of the rainy seasons. As to physical meteorology, the diurnal range of the barometer was mentioned, and allusion was made to the inquiries recently carried out with the view of tracing the modifications of this range, which are due to the geographical position of the station where it is observed. In this connection the great importance of mountain observatories was urged, so as to afford us some information of what passes above our head.

In conclusion, the lecturer said

that the uses of meteorology were so self-evident that he hardly needed to detail them. He cited engineers, physicians, builders, and farmers, as classes whose occupations were seriously affected by weather, and pointed out the great attraction which attempts to foretell the seasons must always possess. At the same time he threw out a word of warning as to the dangers of being guided by mere arithmetical coincidences. Let meteorologists, however, not despair. We have had great men who have laid the foundations of the science, and the face of patient inquirers after truth shows no signs of becoming extinct.

The Fall of Avalanches.—It is very well known to those who have travelled in the Alps that the inhabitants believe that avalanches rarely fall when the sky is overcast, but that they do so frequently when the sky grows clear. In winter the monks of St. Bernard always urge travellers not to leave the monastery when the sky is clearing, and many times those who have neglected that advice have fallen victims to their imprudence. M. Dufour, in a paper read before the Paris Academy of Sciences, endeavours to explain the phenomenon by reference to the contraction and decrease of strength of snow and ice under decrease of temperature. "In cold weather," he says, "when the sky clears off, the temperature falls, especially just before sunrise, and then the filaments of ice which retain the snow on the slopes of the mountains contract and snap, the mass begins to slide, and draws others in its train; for the slightest cause of movement, a shout, or the smallest shock, may cause the fall of enormous avalanches."

A circumstance, of which M. Dufour was a witness, confirmed him in his views. A meadow, of several acres in extent, had been prepared at Morges for skaters by covering it with water, which froze while the heavens were covered. One night the sky cleared off, and M. Dufour noticed a sensible fall in the thermometer. Immediately afterwards he heard crackings in all directions, due to the contractions of the ice from the increased cold, and innumerable splits were observable. That phenomenon is precisely analogous to what occurs when the heavens clear up and cause the fall of avalanches.

Eruptions and Earthquakes in 1878.—In his annual report of these phenomena, just published, Herr Fuchs states that the volcanic eruptions reached the unusually high number of twelve; they were at places far apart, and mostly from little known and rather inaccessible volcanoes. Vesuvius entered on an active period in April. In January, repeated eruptions were observed from previously unknown volcanoes at the south point of South America. About the same time Tanna, in the New Hebrides, was active, and the island of Birara, in the New Britannia group, was devastated in its northern part, while immense quantities of pumice reached far out to sea. Isluga, in South America (in 19° 10′ S. lat.) was the scene of an eruption in February, accompanied with much lava. There

were smaller volcanic outbreaks of Hecla, of Asamayama (in Japan), of Cotopaxi, of Tepaco and Sitna (in San Salvador), and of Isalco. To the more considerable eruptions belong those in the Aleutian and Society Islands; in the latter the islands of Raiatea and Babora were laid waste. A large eruption of mud took place from Paterno, in Sicily.

Coming to the earthquakes, we find 103 recorded; but this enumeration includes as units many complete periods of earthquake, in which shocks and vibrations followed each other at short intervals for days or even weeks. An earthquake in Tanna lasted four weeks, and in the province of Catania earth vibrations were experienced almost continuously from the 4th of October to the 19th of November. Earthquakes were most numerous in winter and autumn. Of the 103, there were 39 in winter, 26 in autumn, and 19 each in spring and summer. The most violent and destructive was that of the 23rd of January, in the province of Terapaca, South America. It was preceded by a long period of vibration from the disastrous earthquake of the previous year. The usual flood-wave which followed wrought even greater mischief than the earthquake in Ariquipa, Pico, Mantilla, and other places. A notable earthquake occurred in the South of San Salvador, destroying nearly all the houses in Jucuapa, and causing much loss of life. The motion, at first wavelike, ended with a violent shock.

Of European earthquakes, that of the 28th of January, in the north-west of France and the south of England, will be well remembered. There were repeated earthquakes in the north-west of Switzerland and the south-west corner of the Black Forest in January and March. The repeated shocks, too, at Innsbruck, 3rd, 10th, 11th of January, 2nd of February, 9th of August; Grossgerau, 2nd of January, 25th of March; Lisbon, 26th and 27th of January, 8th of June; Piedmont, 25th of November; and the continuous earthquakes on both sides of the Bosphorus, from the 19th of April to the end of May, are worthy of notice. In the last the small township of Esmé was quite destroyed, and the English fleet in the Bosphorus experienced the vibration. Interesting, not so much for its violence as for its remarkable extent (relatively to strength), and through the accurate data to hand concerning it, is the Lower Rhine earthquake, which began on the 26th of August. The region affected by the first shock (felt most at Cologne) must have been greater than 2,000 square miles; the shock was felt at Hanover, Offenbach-am-Main, Paris, Utrecht, &c. Supposing the centre 2·5 miles west of Cologne, the rate of propagation of the movement in the earth seems to have been about 6·78 miles. It is noticeable that the earthquake could only be traced near the surface of the ground; the intensity decreased with the depth.

Storms of the Atlantic.—With the aid of a complete series of Hoffmeyer's (daily) charts for two years (1874-5), Professor Loomis, of Yale College, has lately made a careful examination of Atlantic

storms (*American Journal of Science and Arts*). He finds that in one year there are on an average only 18 different storms which can be traced by means of those charts from the coasts of the United States across the Atlantic. Nearly all these storms pursued a course north of east, and passed considerably to the north of Scotland. In only four cases out of 36 did the low centre cross the Paris meridian in a latitude as low as the northern boundary of England. Since the storm centres generally passed 800 miles north of London, most of them did not exhibit much violence on the English coast. Professor Loomis concludes that when a centre of low pressure (below 29·5 inches) leaves the coast of the United States, the probability that it will pass over any part of England is only one in nine; the probability that it will give rise to a gale anywhere near the English coast is only one in six; and the probability that it will cause a very fresh breeze is one in two. A notable point connected with Atlantic storms is their slow rate of progress. This is due partly to the erratic course of the centre of low area; partly to the frequent blending of two low areas into one, so that the eastern centre seems to be pushed backward toward the west. Storms are also often held nearly stationary in position from day to day by reason of the abundant warm vapour rising from the Gulf Stream, close by the cold air from the neighbouring coast of North America. Thus, when American storms are predicted to appear on the European coast and it is assumed that they will cross the ocean at the same rate as they have crossed the United States, such predictions are seldom verified. About half of the (36) storms traced across the Atlantic in those two years seem to have originated in the region of the Rocky Mountains, and four can be distinctly traced to the Pacific coast; the others originated from regions to the east. Professor Loomis's observations on West Indian cyclones seem to prove that these phenomena, however violent in the tropics, expand and lose much of their violence when they reach the middle latitudes, and after a few days are usually merged in some of the larger depressions which generally prevail in some part of the North Atlantic. From observations on Mount Washington, Pike's Peak, &c., the same author concludes that over the United States both the *maxima* and *minima* of atmospheric pressure generally occur first near the surface of the earth, and they occur later as we rise above the surface, the retardation amounting to one hour for an elevation of from 900ft. to 1,300ft.

Glazed Frosts.—A remarkable phenomenon of this nature occurred early in 1879 in some parts of France. We give a few particulars regarding it from letters to the French Academy. According to M. Godfroy, writing from a place in Loiret, rain fell continuously for three successive days (the 22nd, 23rd, and 24th of January), and yet the thermometer remained at 2, 3, and even 4 degrees below zero. When the rain was scanty, each drop at once solidified, even on warm

objects. It took the form of small, flattened, and irregular pastilles. The phenomenon was especially remarkable on woollen stuffs. The drops had evidently been brought to a state of suffusion in their passage through cold air, so that they immediately solidified on meeting solid bodies. When the rain was plentiful, on the other hand, part of it was at once changed to ice, but part flowed down on solid bodies, forming a new layer of ice and producing stalactites. The ice-covered branches of trees broke more and more under the weight, and on the evening of the second day the phenomenon assumed frightful proportions. Crack succeeded crack with growing rapidity. In the morning the ground was strewed with branches, whole trees lay prostrate and uprooted, and others were split in two from top to base. The majority were entirely cleared of their branches, and in some parts the forest looked like one of masts. Such effects will not excite surprise if figures like the following be considered:—A twig from a lime was weighed, and the balance showed 60 grammes per décimètre of length; the same twig, deprived of ice, weighed only 0·5 gramme. A leaf of laurel carried a carapace of ice weighing 70 grammes. All objects exposed were alike covered with ice. M. Piebourg, writing from Fontainebleau, mentions that shrubs with persistent leaves, such as rhododendrons and alaterns, became one block of ice, through which leaves and branches could be distinguished pretty well. Fir trees and the like had the appearance of a huge pyramid of ice, each group of branches being weighed down on the one below, and the lowest on the ground. These trees and evergreen shrubs broke up mostly during the thaw, which commenced on the 25th. The fracturing of the leafless trees, on the other hand, occurred earlier, as the ice accumulated on their branches.

Measuring Sunlight.—A new meteorological instrument has lately been used with much success at the Kew and Oxford observatories, and will doubtless soon meet with more extended employment. It has at present no name, but it might well be called a Heliograph, for its duty is to register, by the action of the sun itself, the exact amount of sunlight which is daily vouchsafed to us. It consists of a solid glass globe four inches in diameter, forming a spherical lens. Placed in a groove in a semi-circular band is a slip of card marked with the hours, upon which the sun's rays are concentrated in a small spot of light. This luminous spot of course travels along the bent card as the day advances, forming on a sunny day a continuous scorched line. But, should the sun be for a time obscured by clouds, this dull period is recorded by a blank which can be exactly measured. The importance of some accurate and automatic record of the sun's attendances and absences is obvious when we consider how much depends upon his light and heat. This instrument is capable of easy adjustment by a milled screw, which shifts the card-holder to any required position.

Meteoric Dust.—Mr. A. C. Raynard, secretary of the Astronomical Society, has recently called attention to the evidence which our earth's surface affords of her passage through meteoric systems. Meteoric dust has been collected on the summits of snow-covered mountains. In the snows of Scandinavia and Finland, or those lying far within the Arctic circle, hundreds of miles from any human habitation, particles of meteoric iron have been found Iron dust has been gathered in ice-holes in Greenland. Nay, in matter raised from the bottom of deep oceans magnetic particles have been detected, which must have been deposited there recently and cannot otherwise have come there save from the air above those oceans, nor have reached that air except from interplanetary space. It is true that all this might have been confidently foreseen. We know in other ways that meteoric matter is constantly falling upon the earth. Yet there is a strange interest in the actual recognition of this cosmical dust. What Humboldt said of the larger meteoric masses which have fallen visibly upon the earth from interplanetary space is true (with slight change) of these more subtle signs of the earth's passage through cosmical dust:—"Accustomed to know non-telluric bodies solely by measurement, by calculation, and by the inferences of our reason, it is with a sense of wonder that we touch, weigh, and submit to chemical analysis metallic and earthly masses appertaining to the world without."

Earthquakes in the East during Ten Centuries.—Dr. Tholozan, the eminent physician of the Shah of Persia, has lately been examining the records of earthquakes in the works of the principal Arabian and Persian historians. The observations extend from the seventh to the seventeenth centuries, and are 111 in number. Of course, the sources of information vary in precision and fulness according to time and place, &c., and the records must be somewhat incomplete; still, they probably serve to afford some idea of the relative frequency of earthquakes in the countries considered. Most of the data relate to intense and considerable earthquakes; in most, houses were destroyed, sometimes entire towns, with loss of life. Dr. Tholozan gives (*Comptes Rendus*) notes of the more notable of these earthquakes, some of which lasted over many days, notably that of Khorassan, in 644. The Mussulman historians often give the accompanying meteorological phenomena with remarkable precision; high winds were frequent, and whirlwinds, also darkness, alarming noises, lightning and luminous meteors.

The numbers of relative frequency of the earthquakes are as follows:—Persia experienced earthquakes 52 times during those ten centuries; 31 times alone, and 21 times along with Syria, Mesopotamia, Egypt, Turkestan, &c. The Persian provinces most frequently attacked were Irak (10 times) and Khorassan (9 times). Mesopotamia (according to the records) was 23 times attacked; 7 times alone and 16 times with neighbouring countries. Egypt was attacked 18 times alone and 9 times along with other coun-

tries; Syria only 9 times alone, and 17 times with other countries. The results of this inquiry correct two assertions that have been made. One is that of Van Hoff, that from the commencement of the thirteenth to the latter half of the seventeenth century there was an almost complete cessation of earthquakes in Syria and Judæa; the other, that of the celebrated Orientalist, Quatremère, that the north-east portion of Africa, comprising Egypt, has been nearly always exempt from earthquakes. In Egypt 27 earthquakes are recorded in seven centuries (796–1482); this gives about four earthquakes in a century.

International Meteorology.—The War Department of the United States Army has now for some time past been the headquarters of a system of weather reports which is under the direction of the Chief Signal Officer, General Myer, which has constantly been extending its area and its usefulness, and which is fairly entitled to claim the cordial co-operation of other countries. The warnings of coming storms which we have lately so often received from America have been due to the labours of this Meteorological Department; and it cannot fail to be interesting to our readers to learn something of the method by which the records available for such purposes have been obtained.

The most remarkable feature of the United States observations consists of a series of charts which are based upon the state of the barometer, the thermometer, and of the weather generally, in different parts of the globe at the same instant of physical time. The work is so arranged that the observations, say at Washington, St. Petersburg, and Constantinople, are not taken at the same hours of local, or clock time, in the three cities, but precisely at the same moment; the readers or observers being all actually at the instruments at once, and so for all other stations. The atmosphere over any extent of the earth can thus be viewed as a whole and before any movements or changes in it are possible. The charts on which the observations are recorded give a true synopsis—it might almost be called a photograph—of the atmosphere and its conditions at the instant. The results, called "simultaneous observations," and which are characteristic of the work of the United States Office, were first employed by it for the purposes of prediction in 1870, and are now, at the invitation of the Office, taken widely throughout the world. They are collated under the direction of General Myer at Washington, and are printed and issued daily, forming the "international bulletin of meteorological observations taken simultaneously." They embrace observations taken by almost every civilized Power north of the equator, as well as observations taken at sea. In order to satisfy the many inquiries concerning the condition, scope, and progress of the labour connected with these international simultaneous observations, a special report upon the subject was made by the Chief Signal Officer to the Secretary of War, under date of November 1st, 1878; and of

some of the chief features of this report the following is a condensation:—

At a congress of persons charged with meteorological duties, which assembled at Vienna in 1873, it was resolved to be desirable that at least one uniform observation, of such a character as to be suited to contribute to the formation of a synoptic chart, should be taken, recorded, and exchanged, daily and simultaneously, at as many stations as possible throughout the world. This recommendation has continued to be of practical effect; and by the authority of the United States War Department, and with the courteous co-operation of scientific men and chiefs of meteorological services representing the different countries, a record of observations taken daily, simultaneously with the observations taken throughout the United States and the adjacent islands, has ever since been exchanged semi-monthly. These reports now cover the territorial extent of Algiers, Australasia, Austria, Belgium, Central America, China, Denmark, France, Germany, Great Britain, Greece, Greenland, Iceland, India, Italy, Japan, Mexico, Morocco, the Netherlands, Norway, Portugal, Russia, Spain, Sweden, Switzerland, Tunis, Turkey, British North America, the United States, the Azores, Malta, Mauritius, Sandwich Islands, South Africa, South America, and the West Indies.

On July 1st, 1875, the daily issue of a printed bulletin exhibiting these international simultaneous reports was commenced at Washington and has ever since been continued, and a copy of this bulletin is furnished to every co-operating observer. The results afforded by the reports thus collated are considered to be of especial importance, and the bulletin combines, for the first time of which there is any record, the labours of all nations in a work for their common benefit. There is only needed the assistance of the navies of the different Powers (that of the navies of the United States and Portugal being already given) to extend the plan of report upon the seas in order to bring fully within the scope of study observations extending around the whole of the northern hemisphere. This end is to a great extent already attained, since a number of observations taken on vessels at sea, at the request of the War Department, and in order to complete the synchronous reports of the land service, are now regularly received upon the forms provided for the purpose. The utility of such observations is manifest in their bearing upon the study of storms which are approaching coasts, or which may endanger vessels on their departure. The co-operation of the United States navy, wherever the vessels may be, has been assured by a general order of the 25th of December, 1876, and has largely increased the data of this class. The required observations have been skilfully taken throughout the service, and the people of the United States are thus the first nation whose army and navy co-operate, as all armies and navies should, under official orders, in the work of simultaneous meteoro-

logical observation wherever the forces may be stationed. To facilitate the co-operation of vessels of the mercantile marine, carefully tested barometers of the best make have been prepared as standards, and are placed at New York and at San Francisco under the charge of sergeants of the Signal Corps, who attend daily in order to take charge of any ship's barometers which are brought for comparison, and to give any information which may be required. The officers of the Signal Service at the different cities and ports of the United States are also instructed to offer every assistance in their power to the vessels of any nation.

With the plans for charting now adopted at the Washington Office, and with the reports now received there, it appears that the meteoric changes occurring over a great portion of the continents north of the equator can be laid down with an accuracy sufficient to permit careful and valuable study. This charting, to be of the greatest attainable value, must be supplemented by the records of observations taken on the seas. A ship at sea becomes one of the stations for a simultaneous system. There is no sea-going vessel which does not carry human life, and each ought to carry, by compulsion if need be, meteorological instruments. The smallest craft, in caring for its own safety, may soon use them so as to add to the value of the most extensive record. There is no nation which is without interest in the work proposed to be based upon exchanged simultaneous reports, and no nation has hitherto hesitated, when the subject has been properly presented, to aid in a duty which, so easily done as to require very little effort on the part of any one person, has for its object a good to mankind. The work cannot, from its nature, be for the selfish good of any section.

A number of the great steamship companies traversing the principal commercial sea routes have promised to give their powerful influence and aid; and the United States, in the case of maritime observers co-operating in the system, will, when so desired, bear all expenses of forms, postages, &c., and will also, when necessary, lend the required instruments. The number of observations made daily on separate vessels at sea already exceeds one hundred.

Even when predictions are not directly practicable, research has already been carried far enough to indicate the paths through which to learn what sequences will be found on the American western coasts consequent on conditions reported as existing on or near the eastern coast of Asia or on the Pacific Ocean. Similar studies will have reference to the southern and eastern American coasts, and the western coasts of the European continent. The time cannot be far distant when vessels leaving any Atlantic port may be informed whether any notable disturbance exists at sea, and where it is likely to threaten the voyage. The establishment of permanent stations in lines traversing the oceans over or near the telegraph cables, and maintained in telegraph communica-

tion with either continent, is not considered impracticable. There is good reason to hope that progress has already been made which will soon remove from the study of practical meteorology some of the chief difficulties against which it has had to contend, and also that atmospheric conditions and changes of condition can be charted with sufficient accuracy over any extent of the earth's surface. If this hope should be fulfilled, meteorological barriers against study will practically cease to exist.

Although the stations are crowded in some localities, each one of them is useful, either by serving to check the work of others, or by aiding to close gaps which the failure of others might sometimes cause. It is even believed that a still more extensive system would permit of generalisations by which meteoric changes might be announced for longer periods in advance than has hitherto been practicable.

The average number of daily simultaneous observations now made in foreign countries is 293. The total number of stations on land and on vessels at sea from which reports are regularly entered in the bulletin is 557. The co-operation of the different nations secured by the plan of exchange renders the additional cost to the United States of the grand system of reports it makes possible but little more than the cost of the preparation, paper, and binding of the international bulletin and the accompanying charts—a cost the greater part of which would have to be incurred for the proper preservation of the records themselves, even if the bulletins were not distributed. As one result of the international co-operation which had been obtained, it became possible on the 1st of July, 1878, for the first time to commence the publication of an international weather map, charted daily and issued daily, each chart based upon the data appearing upon the international bulletin of simultaneous reports of similar date. The charting extends round the world, and embraces for its area the whole northern hemisphere. The study of such charts makes possible the improvement which will come as the work progresses, and as the area of the chart is better filled with the results of observations carefully elaborated by scientific men.

The questions as to the translation of storms from continent to continent and of the time and directions they may take in such movements; the movement of areas of high and of low barometer; the conditions of temperature, pressure, and wind direction existing around the earth at a fixed instant of time, permitting thus the effects of day and night to be contrasted; the distribution and amount of rainfall, and other problems, many and important, which are only suggested by this enumeration, may by such means be settled. It seems not impossible that in the future questions of climatology, and perhaps others bearing upon the prediction of changes far in advance of the time at which they may happen, or questions of the character of coming seasons even, may be answered by the researches which

these charts will render practicable. As a means of better combining the work and the interests of the several nations concerned; of certainly securing the co-operation at sea which will enable the lines of charting to be drawn as fully and as well over oceans as over continents; and which will ultimately give the world as practical a knowledge of the movements of areas of disturbance in the midst of the seas as is now possessed of such movements on some continents, the undertaking is of vast importance.

It is among the advantages of the charting drafted from simultaneous reports that studies by normals, not possible in any other way, can be made. The normal pressure, temperature, &c., arrived at from observations taken at any one place at the same fixed instant of time every day become established, as to that place and time, with accuracy, and many sources of error are thus removed. The comparison of such normals with those taken at other places simultaneously with the first and under similar conditions gives results which are trustworthy, and which are very different from those arrived at by the use of normal readings determined in any other manner. The comparison of such normals will show in the case of abnormal changes in any district or section, for any season, whether and how they are attended by compensating variations elsewhere. There are many interesting studies as to what sequences may be expected to follow any given variations occurring over any region or country, either in that region or country or in some other; and how and where the compensating variations occur and with what concomitants or sequences of meteoric changes. In this way, or by investigations which such study may suggest, there is good hope of ultimately gaining knowledge which may greatly benefit the commercial and agricultural interests of the world. The Government of the United States by thus boldly and comprehensively establishing a great scientific undertaking has set an example which can scarcely be too highly commended or too closely followed in all other countries of the world.—*Times.*

Iron Particles in the Air.—Observations on snow collected on mountain-tops and within the Arctic Circle, far beyond the influence of factories and smoke, confirm the supposition that minute particles of iron float in the atmosphere, and in time fall to the earth. Some physicists believe that these floating particles of iron are concerned in the striking phenomena of the aurora. Gronemann, of Göttingen, holds that streams of the particles revolve round the sun, and that when passing the earth they are attracted to the poles, and thence stretch forth as long filaments into space. But as they travel with planetary velocity they become ignited in our atmosphere, and thus produce the luminous appearances or auroræ. In his recent voyages, Professor Nordenskiöld examined snow far in the north beyond Spitzbergen, and found therein exceedingly small particles of metallic iron, phosphorus, cobalt, and fragments of diatomaceæ.

VI.—HEAT, LIGHT, AND SOUND.

The Velocity of very Loud Sounds.—It is known that the velocity of a musical sound is, within wide limits, independent of its intensity and pitch. Music from a military band at a distance, *e.g.*, comes to the ear with quite undisturbed harmony; but in the case of a loud and sharp shock or explosion there are reasons for doubting if the velocity of propagation be constant and identical with that of a musical sound. This matter has been lately put to the test of experiment by Mr. William Jacques at the United States Arsenal, in Watertown, Massachusetts. A 6lb. brass field-piece was placed in the midst of a large level field, and behind it, at distances ranging from 10ft. up to 110ft., were placed a series of membranes electrically connected with a chronograph, which would thus give the instant at which the sound-wave from the gun met each membrane in succession. The experiment was repeated many times, and always with the same result. It was found that immediately in the rear of the cannon the velocity of sound was less than at a distance, but that, going farther and farther from the cannon, the velocity rose to a *maximum* considerably above the ordinary velocity, and then fell gradually to about the ordinary. When the gun, however, was pointed at right angles to its first position, it was found that the position of *maximum* velocity was brought nearer to the cannon, and if the gun had been turned in the direction of the line of membranes, which was impracticable, it is thought the retardation which produced the first low velocities would probably have become an acceleration. The heaviest charges of powder caused the greatest deviations from the ordinary velocity. The experiments, accordingly prove that the velocity of sound depends, to some extent, on its intensity, and that experiments on the velocity of sound in which a cannon is used contain an error, probably due to the bodily motion of the air near the cannon. Evidently a musical sound of low intensity must be used for a correct determination of the velocity of sound.

How to Measure the Velocity of Sound.—M. Bichat (*Journal de Physique*, vii., 330) describes a simple and ingenious arrangement for exhibiting and measuring the velocity of the propagation of sound in air and other gases. A tube about ten metres long, made of tin plate, is bent so that its extremities are near together. One extremity is closed by an indiarubber membrane; the other carries a cork with a glass tube through it, which communicates by means of an indiarubber tube of a certain length with a Marey's mano-

metric capsule. Close to the extremity closed by the indiarubber membrane the tin tube is pierced by an opening, which, through a second indiarubber tube of the same length as the first, communicates with another manometric capsule. These capsules are arranged in front of a blackened cylinder, so that the extremities of their levers rest upon the same generating line. Close by these a tuning-fork, making a hundred vibrations per second, is placed, and inscribes its vibrations side by side with those of the manometric capsules. The experiment being so arranged, a slight shock is given by the hand to the membrane, the blackened cylinder meantime being turned. The capsules register the point of departure and the point of arrival, while the tuning-fork gives the time. In this way the velocity of sound in air was found by M. Bichat to be 333·3 metres per second. By means of two tin tubes, placed one above the other, we may, in a single experiment, demonstrate the difference of the velocities of sound in air and in hydrogen; but it is difficult, in consequence of diffusion through the indiarubber, to keep the tube full of pure hydrogen.

Studies in Acoustics.—Mr. W. H. Preece and Mr. Stroh, on the evening of the 27th of February, 1879, brought before the Royal Society a paper giving some of the results of their studies in acoustics. It dealt with their researches in synthetical examination of vowel sounds. They have during the last year devoted much time to the study of acoustics and the improvement of the telephone and phonograph, and some of their results were exhibited. The first was a new form of diaphragm which intensified the loudness and removed some of the imperfections of the present disc of the phonograph. They had sought for one which should give all the finest shades of sonorous vibrations, and, after innumerable experiments on almost all known forms and substances, a stretched membrane of thin indiarubber rendered rigid by a cone of paper was found to give the best effects. The next was a new phonautograph to record the vibrations of this disc on paper. The ink employed was aniline dye, and it was drawn through the pen by the very slight friction exerted between its point and the paper. The next apparatus was a machine for tracing curves of the composite character which represent the sounds of speech, especially the vowel sounds. By this machine they are able to build up curves by putting together their constituent parts, however much they vary in phase and amplitude, and thus to study the various theories with regard to vowel sounds which have been put forward.

Several instruments were shown by which the vowel sounds were reproduced with more or less exactitude by vibrating a disc in accordance with the curves formed by the curve machine. One of them makes a simple and good siren, reliable for measurements, and gives promise of introducing a new musical machine which will give sweet sounds by the mechanical vibration of a disc. Though the knowledge of vowel sounds is far from complete,

Helmholtz's theory has been fully confirmed by the work the authors have done. The sounds cannot, however, be, they say, exactly reproduced by mechanical means at present. Some interesting experiments were made on the loudness of sound, tending to show, it was urged, that sufficient importance has not been attached to the quantity of air thrown into vibration. Discs of different diameter, though vibrated with the same amplitude and pitch, increase in loudness very largely with the increasing dimensions of the disc.

Researches on the Velocity of Light.—The United States National Academy of Sciences appointed a committee a short time since to consider a plan proposed by Professor Newcomb for determining the distance of the sun by measuring the velocity of light. The committee's report was so favourable to the plan proposed that it was sent to the Secretary of the Navy for transmission to Congress. An appropriation of $5,000 for the purpose has been secured, and the work of constructing the necessary apparatus will be commenced as soon as the appropriation is available. We further learn that at the United States Naval Academy, Annapolis, Ensign Michelson has begun (under orders from the Naval Department, and with funds supplied by Mr. A. G. Heminway, of New York) the erection of apparatus for the more accurate determination of the velocity of light. His method is described as essentially that of Foucault, with the exception that a lens of great focal length and a plane mirror are used. This permits the use of a considerable distance, giving a longer interval of time and insuring greater accuracy. The displacement of the image of a slit is the quantity to be measured, and while this, in Foucault's experiments, was a fraction of a millimètre, it is increased in Ensign Michelson's experiments to over 100 millimètres. The error introduced in this new measurement, would be less than one-thousandth of the whole, or less than 20 miles. Another feature is the use of a tuning-fork, bearing a mirror on one prong, and kept in motion by an electric current, by means of which the speed of the revolving mirror can be ascertained with much precision. The revolving mirror is put in motion by a blast of air furnished by a small rotary blower, which is turned by a steam-engine. By this means a very steady speed is maintained.

The Reflection and Refraction of Light.—Within the last few years Professor J. Clerk-Maxwell has shown the probability that all electrical phenomena are due to pressures in the same ether, and this has long been assumed as the means of the propagation of light. Acting upon his assumption, Professor Clerk-Maxwell has deduced what the laws of transmission of light in ordinary crystalline and magnetized media would be, and from such deductions he at once arrived at the well-known laws of these phenomena. In a paper recently read before the Royal Society, Mr. G. F. Fitzgerald, F.T.C.D., has at some length investigated the laws of the reflection and re-

fraction of light, acting upon the same assumption, and he has obtained just the same results as Professor M'Cullagh long ago deduced from his theory, and which are known to represent almost exactly the laws of reflection and refraction at the surfaces of ordinary and crystalline media. Still further he investigated the laws of reflection at the surfaces of magnets, with theoretical results which essentially agree with and completely confirm Mr. Kerr's quite recently published beautiful experiments on the reflection of light from the pole of a magnet.

The Effect of Air Currents on Hearing.—Professor Tyndall's experiment will be remembered, in which, by means of a row of heated air currents with colder air between these, he proved that air currents of varying density are a great obstacle to the passage of sound waves. It has been lately observed by Mr. Jacques, of the John Hopkins University, Baltimore, that the sound transmitted through such air-strata loses not only in intensity, but in distinctness. (The ear was substituted for Tyndall's singing flame.) The effect was most marked on a man's voice, or a musical instrument (like a flute) with few overtones. In the former case each syllable seemed to be repeated several times in very close succession. The explanation given is (briefly) that the original ray is partly reflected and partly transmitted at each variation of the density. The reflected portions are not wholly lost, but in passage backward are re-reflected and divided like the primary wave, so that a series of secondary waves comes to the ear after the primary and masks the distinctness of the original sound.

Some interesting observations were made in halls in connection with the subject, especially in the Baltimore Academy of Music. The acoustic properties of this place (which seats 1,600) are very good; the weakest voice is audible to every seat; sounds like a sigh or a kiss can be heard at the most distant parts, and music is exactly rendered. Now the supply of fresh air comes in behind the stage, crosses this horizontally, passes through the proscenium, then somewhat diagonally to the roof in one grand volume of about 15,000ft. per minute, with gentle motion, and almost without minor air-currents. The exhaust is partly by a centre outlet in the roof, partly by numerous registers in the ceilings of the galleries; from these the air passes into the ventilating tower over the great chandelier, whence it escapes through valves allowing free egress but refusing entrance. That the good acoustic qualities of the hall were largely due to the condition of the air was shown thus:—Persons were stationed at different parts of the house during a performance (without knowing of the experiment to be made) and were simply asked to note, at several intervals during the evening, the comparative ease with which they could hear the performers. At various intervals the valves controlling the ventilation were reversed so as to entirely interfere with the unbroken state of the air and give rise to currents of circula-

tion. Almost invariably the testimony of the hearers would be that at times corresponding to the interruption of the ventilation (soon after the interruption) "the sound was dead, was confused and indistinct," and it would be observed that people all over the house would make an effort to listen. These experiments were repeated at various performances, and always with like results, proving a distinct effect of air-currents on the acoustic qualities of an auditorium.

Some Recent Acoustical Researches.—The harmonic overtones which accompany a musical note are a well-known phenomenon, and their nature has been made pretty clear. There is another phenomenon presenting a certain analogy to this. It has lately been studied by a German physicist, Herr Auerbach, who applies to the notes generated the corresponding name of undertones. These undertones may be had by striking a tuning-fork vigorously, then placing its stem very lightly on a table-plate. One hears the lower octave of the fundamental note of the tuning-fork. With suitable materials, Herr Auerbach also obtains the lower fifth of the lower octave, and the lower fourth of this tone—that is, the double octave of the fork's tone; in fact, these resonance tones form a series of harmonic undertones. The phenomenon appears to depend essentially on the strength of the vibrations and the imperfect elasticity of the resonance-surface of the plate. Herr Auerbach has tried a variety of substances for undertones with tuning-forks. He finds that some, indeed most, substances give these tones; that some give only a noise, as soon as the vibrations are moderately strong; and some always give the tone of the fork, no matter how strongly this is sounded.

Another German observer, Herr von Strouhal, has recently given some attention to a kind of tones not much studied hitherto, viz., those which arise when a rod or the like is quickly swung through the air, or when currents of air impinge on stretched wires or sharp edges, &c. For pureness of tone. the swung rod must have all its parts moved with the same velocity, and it must be cylindrical. Herr Strouhal made an apparatus consisting of a vertical wooden column with two horizontal arms, between which the bodies to be forced through the air (mostly wires) were fixed, and he rotated the frame in its upright position at various speeds. Thus he got notes which rose in intensity and pitch with the speed. He found that the pitch of the "friction tone" (as he calls it) is independent of the tension of the wire, likewise of its length. But the length of the wire has a marked influence on the intensity of the tone. The longer the wire, the stronger (*cæteris paribus*) the tone. Further, the substance of the body is a matter of indifference; but the height of the tone is directly proportional to the velocity of motion, and inversely so to the diameter of the wire.

The author finds, moreover, that there is a way of making the "friction tone" produce the wire's own tone, viz., when it is brought up to the same pitch with this

(the wire being preferably thin and elastic), and similarly, by raising the pitch gradually higher, the succession of overtones of the wire are generated. The distinct character of the general phenomenon above indicated appears from the fact, among others, that with rising temperature the friction tone becomes lower. The true nature of these tones is at present somewhat obscure. Herr Strouhal offers, with reserve, an interpretation of the facts, for which, however, we must refer the reader to his original paper in the "Annalen der Physik und Chemie."

The Transmission of Sound; Singing and Dancing Flames.—Professor Tyndall, D.C.L., F.R.S., delivered a lecture on Sound, at the Royal Institution, on Feb. 27, with illustrations of the fact that the brilliancy of a musical note greatly depends on the mixture of the higher, or harmonic notes, termed "over-tones," with the fundamental note. He showed the persistence of the octave on a string when the fundamental was quenched, and the production of different tones by plucking the string near the end or the middle, and also by different modes of striking it. "Sympathetic vibration" was next considered. A light and a heavy tuning-fork were sounded simultaneously and shown to emit the same note, and both were then quenched. The light one only was then struck, and the sound was transmitted to the other; and when the light one was quenched, its sound was revived by transmission from the heavier one. After repeating the experiment in various forms, showing how the forks reacted upon each other, the Professor exhibited the phenomena of singing flames in various ways: thus, a gas flame in a globe started into song when its corresponding note was sounded on the pitch pipe. The interesting experiments of Plateau, made with drops of olive oil in a state of equilibrium in alcohol and water, were described; and it was explained, by their means, how, in a liquid jet, the lower part of the jet is elongated and flattened, so as to form spherical drops. This was beautifully illustrated; and, by means of the electric light and a flashing wheel, the lower part of a liquid jet was shown to consist of drops. The influence of the sound produced from an organ pipe upon the jet in breaking it up into drops was also exhibited. The sensitiveness of flames to sound, first observed by Leconte, was then demonstrated by gas-burners. The flame, when upon the edge of flaring, became much agitated, and literally danced at various sounds, such as those of keys, bells, and the human voice, being especially sensitive to the letter S. Finally, the effect produced upon smoke jets by sounds, in breaking up their continuity, was exhibited in a striking manner.

VII.—ELECTRICITY AND MAGNETISM.

Clocks moved by Electricity.—A very ingenious clock-dial, the hands of which are actuated by electricity, has lately been introduced into England. The object of this invention is to carry the time from one standard clock to a multitude of dials which may be placed at any distance apart, but must be connected by wires. Thus the various clocks of a village or town might be governed by one central chronometer. The mechanism is very simple. It merely consists of a rachet wheel in connection with the usual hour and minute wheels, and an electro-magnet, the armature of which acts upon the rachet. So much for the independent dial. On the axis of the driving clock's minute wheel are four studs, which, of course, pass a given point at quarter-minute intervals. At this point is a catch, contact with which completes an electrical circuit, and causes each electro-magnet in that circuit to clutch its armature. This causes the minute-hand on each dial to move forward fifteen seconds. Inconceivable as it may seem, it would be possible on this principle to work the Westminster clock from an ordinary chronometer placed at a distance from it. As a matter of fact, the hands of the large clock at the late Paris Exhibition, the dial of which was only two feet less in diameter than the Westminster timekeeper, were so moved. This clever invention is patented in the name of M. Firnhaber.

Engraving by Electricity.—A M. Bailey, of Paris, has invented an electric spark pen which possesses some points of interest. If a sheet of thin paper is attached to a plate of copper or zinc, it is stated that an engraving may be made with extraordinary facility by means of this pen. If one of the poles of a Ruhmkorff machine is attached to the plate and the other to the upper end of the pen, the current will run through, and, in drawing, the paper is perforated. When the drawing is finished, ink is laid on with an ordinary roller, and the greasy fluid penetrates through the holes. The plate is then plunged in water, which detaches the paper, and is ready for immersion in the acid. The advantage claimed for this method is that the artist does all parts of his work, and has no more trouble than if he were working with an ordinary pencil. He can even work in a dark room without any other light than the glare from the induction spark.

The Tasimeter.—The extreme sensitiveness of the "carbon button," used in the transmission of sounds by the microphone, has led Mr. Edison to the invention of a new instrument, the Tasimeter, for measuring minute changes of temperature. The button is placed so that substances of different kinds may be brought near it;

and when in operation, the instrument is connected with an electric battery, and a very sensitive galvanometer. The slightest pressure on the substance taken for experiment immediately deflects the needle of the galvanometer. Suppose, for example, that the substance is a small strip of metal; the pressure has altered its length, and consequently its relations with the button, and the sensitiveness of the button at once makes the fact apparent through the galvanometer. Similarly, changes of temperature and of moisture are indicated, and thus physicists are provided with an additional resource for experimental purposes. With the tasimeter one can measure with greater refinement than hitherto the temperature of the spectra of stars, and determine the quantity, infinitely small though it be, by which a wire or bar is lengthened or shortened by magnetisation; and ascertain many other facts which are of great importance in physical science. For instance, a tasimeter may be so fitted in the keel of a ship that when connected with a galvanometer in the cabin, it will indicate the temperature of the sea, and the proximity of ice. Similarly, it may be used to give warning of excessive heat and of fire.

An Electrical Burner and Blow Pipe.—The electric arc is, of course, part of a current, and is, therefore, affected by neighbouring currents and magnets, as currents are, according to the laws enunciated by Ampère. Thus, the arc between two vertical and parallel carbons may be displaced up or down by holding one or other pole of a magnet near it. And with a rectangle of wire placed vertically round the carbons, and traversed one way or the other by currents, like effects may be had. These principles have been recently applied in an ingenious way by the eminent French physicist, M. Jamin. A rectangle of wire is arranged as stated. The current is sent up, say, the left carbon, down the right, then round the (incomplete) rectangle in the direction of the hands of a watch. To make the "candle" entirely automatic, the two carbons are rendered movable about two joints at their lower ends, and while the current is not flowing they are brought together at the top by the action of a spring.

Directly the current is started, the carbons come apart (through the attractive and repulsive actions of the current in its successive paths). The arc is formed and continues at the top. With the current always in one direction, one carbon is consumed more than the other, and the arc descends with it; with alternating currents both carbons are consumed alike. Now, a special point noted by M. Jamin is that when the action of the rectangle is strong enough, the arc is forced beyond the points, and takes the form of a gas flame, with strong sonorous effect, or a kind of roar. There is then a greater expenditure of electromotive force; but the light does not increase in proportion. M. Jamin, however, made the jet or flame impinge on a piece of lime, magnesium, or zirconium. Thus, electromotive force is saved, and a beautiful

light is obtained, which is thrown downwards, so that the lamp can be elevated more than usual. The light is no longer violet, but white; with lime it looks somewhat greenish yellow, and the cap of lime at least triples the brightness of the light The temperature of this electric jet is very high, and, indeed, the lime must not be brought too near the point, else it is fused. M. Jamin points out, therefore, that we have here a kind of blow-pipe which is probably the most powerful of all. He recommends it to physicists and chemists, and promises to describe ere long some of the effects he has obtained with it.

Electric Lighting.—The report of the Select Committee of the House of Commons on Electric Lighting was published during 1879, and may be regarded favourable to the new process of illumination; but not favourable to the conferring on gas companies the privilege of laying on the electric light, which, committed to their care, might have a slow development. And the Committee are of opinion that the time has not yet arrived for giving general powers to private electric companies to break up the streets; but the proprietors of large buildings, lecture-halls, theatres, factories, are free to generate electricity for their own use without further delay or legislative sanction. As regards the light itself, attention is drawn to the peculiarity that it produces a transformation of energy in a singularly complete manner. The energy of one-horse power, for example, may be converted into gaslight, yielding a luminosity equal to twelve-candle power; but the same amount of energy transformed into electric light produces sixteen-hundred-candlepower. "It is therefore not surprising," as stated in the Report, "that while many practical witnesses see serious difficulties in the speedy adaptation of the electric light to useful purposes of illumination, the scientific witnesses see in this economy of force the means of great industrial development, and believe that in the future it is destined to take a leading part in public and private illumination. On one point all are agreed—namely, that the electric light will produce little of that vitiated air which is largely formed by the products of combustion of ordinary illuminants." And further, the scientific witnesses are of opinion that "in the future the electric current may be extensively used to transmit power as well as light to considerable distances, so that the power applied to mechanical purposes during the day may be made available for light during the night." On the question of cost compared with gas, the Committee are not of opinion that the economy for equal illumination has been conclusively established.

An Electrical Rock Drill.—The electric currents of high tension, which M. Planté has been studying for some years past, give many curious and suggestive effects. They are obtained from his secondary batteries, which are charged from an ordinary galvanic battery, and each cell of which consists essentially of two sheets of lead rolled up together, with an insulating substance between them, and im-

mersed in a dilute solution of sulphuric acid. One of the effects just referred to is that of electric engraving on glass. When one of the electrodes conveying the current of the secondary battery is brought into contact with glass, in presence of a saline solution, it acts like a graver or diamond, making grooves and hollows on the surface of the glass, often to a considerable depth. Rock crystal may be attacked by the same method, notwithstanding its hardness. When it is not regularly engraved, it at least cracks into small fragments under the influence of the electrode, and is at length disaggregated. Such effects have led M. Planté to the idea of utilizing this force in boring operations. In America and elsewhere, it is known, hard rocks are often attacked by means of diamonds, the price of which is, of course, high, and which are gradually lost by being detached, through the violence of the action, from the pieces to which they have been fixed. "Might not these diamonds be replaced," M. Planté asks, "by the action of the electric currents referred to, and the rocks be bored by electricity?" He points out that electrodes of platinum would not be necessary; for it is not the metal of the electrode that is altered, but the silicious matter, in presence of the saline solution. Metallic points or projections suitably placed at the extremity of the drill rod, insulated in a portion of its length, and animated by a rotatory movement, would bring the electric current to the surface of the rock to be pulverized, and would thus replace the numerous diamonds set in the head of drills employed in the present system of rock-boring. The progress recently accomplished in production of electricity by mechanical methods might facilitate this application.

A New Thermo-Electric Battery.—It has long been the aim of practical electricians to devise some means whereby heat could be utilised as a source of electrical energy. This was first accomplished by Seebeck in 1822, who found that heating the points of junction of two dissimilar metals gave rise to a feeble electric current. He, therefore, constructed a battery of these metals, heat being the source of power. Further experiments of Wheatstone, Bunsen, Noë, Marcus, and others led to improvements in the instrument, and a consequent increase of strength in the current, until a thermo-electric battery was, we believe, introduced into the London General Post Office for telegraphic purposes. It failed practically, however, on account of the cost of the metals employed and their deterioration by use. It still remains to be seen whether the ones recently devised are more permanent; they are certainly not costly, and, so far, have proved very successful. According to the report published in a French scientific journal, and confirmed by the well-known electrician, the Compte du Moncel, M. Clamond has succeeded in devising a thermo-electric battery, producing a current sufficiently powerful to yield the electric light. A factory in Paris is now, indeed, lighted by this means, and a further improvement in the instru-

ment was shown in a recent exhibition of the various systems of electric lighting held at the Albert Hall.

The apparatus consists of three parts : an inner one, composed of pieces of iron arranged in the form of a crown, which can be heated in the interior. This is called the collector, its purpose being to collect the heat and then communicate it to the adjacent thermo-pile proper. This consists of a flexible chain, of any desired length, composed of cubes of antimony and zinc, soldered together by sheets of tin. In the complete apparatus there are 6,000 of these "couples," outside which are fixed the plates of copper to diffuse the heat of the collector. A large surface is thus exposed to the air, in order that as great a difference of temperature as possible may be maintained between the collector and the diffuser, for upon this difference the strength of the current chiefly depends. M. Clamond has been so successful that with one of his batteries he has been enabled to light two of Serrin's lamps; and with a smaller, but equally powerful battery, he can light four less brilliant lamps. This is done with the consumption of 9 kilograms, or about 20lbs. of coke an hour for the larger, and 6½lbs. for the smaller, thermo-electric battery. The apparatus, moreover, gives warmth as well as light, since its large exterior surface causes it to radiate a considerable quantity of heat.

Curiosities of Magnetism.—Needles may be used as magnets, and made to float vertically in water by attaching a speck of cork to the eye end. If, while thus floating, a large magnet is held over them, they arrange themselves in certain definite groups, which, according to Mr. A. M. Mayer (United States), exemplify molecular structure and molecular action. In some instances the groups assume an unstable form; but by a movement of the upper magnet, or at times a knock on the table, they take up a stable configuration. These configurations may be recorded—if, before immersion, the upper ends of the needles have been touched with printers' ink—by laying upon them a piece of flat cardboard, when the place of each needle will be shown by a dot; and by drawing a straight line from dot to dot the representative forms will become at once apparent. From the triangle, square, and pentagon, they pass into hexagons, octagons, and decagons, and compose groups within groups: "stable nuclei, which may be suggestive to chemists and crystallographers."

Electricity for Vicious Horses.—It has been proved in Paris that vicious horses may be effectually cured by electro-magnetism. With bits, bridles, nose-bands, and curbs, specially constructed, so as to apply a gentle current to the required place, the current being supplied by an electro-magnet easily portable, seven of the most violent horses among 12,000 were reduced to obedience, and allowed themselves to be shod. Some horses required two applications, some three; but all were completely cured of their vicious propensities, and without any weakening or stupifying effect. Particulars of the method of treat-

ment, and the results, are published in the Procès verbaux of the *Société d'Encouragement pour l'Industrie Nationale.*

The Electric Light.—Professor Tyndall early in 1879 delivered a discourse before the Royal Institution, his subject being "The Electric Light." He commenced by expressing his thanks to all the gentlemen who had afforded him information about the various arrangements for electric lighting now before the public, and those which have for awhile held their ground but have been superseded. The electric light has been known for 70 years, as in 1808, and again in an improved form in 1810, it was shown to audiences at the Royal Institution. Sir H. Davy's carbon points "threw sunshine into the shade," and in 1808, 2,000 pairs of plates, obtained for the Institution by subscription among the members, produced such heat from the current they gave that quartz and calcium were melted as wax. It was early known that to produce heat and light in a circuit there must be resistance. This was illustrated by a wire composed alternately of platinum, which resists, and of non-resisting silver, when on the passage of a current the platinum became dazzlingly white hot. A non-resisting copper wire will carry enough electricity to split a resisting oak tree. In the case of two carbon points this resistance causes the one point to waste with double the rapidity of the other. This, which was formerly regarded as one of the two great obstacles to the general introduction of the electric light, had been overcome by various appliances of clock-work, which kept the two points at the proper distances apart.

The second great obstacle was a more serious one, depending on an inexorable law of nature which demands an expenditure of force of one kind for the production of another. Zinc may be burnt in air—that is, oxidized; it may be also "burnt" or oxidized in acidulated water, but it has to displace the oxygen from the hydrogen for this to occur, and four-fifths of the heat produced are used up in this process So that when zinc is thus "burnt" only the remaining one-fifth is available. The rate of "burning" makes no difference; one ounce of zinc, for example, always gives out the same amount of heat. This "burning" of zinc, which had been used in the production of electricity, was an expensive fuel, and this seemed to be a very great drawback to the general use of the electric light.

In the year 1831 a discovery was made at the Royal Institution by Faraday, that of magneto-electricity. He showed that when the earth's line of magnetic force is cut an electric current is produced. Professor Tyndall quoted Faraday's saying, that he would rather occupy himself with finding fresh effects, than spend his time in exalting those effects. But it was the exaltation of those effects which he first studied in a simple way which has led to the present possibilities of our electric lighting. In 1854 Werner Siemens, of Berlin, invented what is now known as a Siemen's armature, with 16 permanent magnets, in the working of which there is only the ordinary mechanical

friction to be overcome. Working the machine by hand, the expenditure of muscular force becomes apparent as heat through the machine. But this and the Wylde and Gramme machines in the same way show that the external work falls short of the originating work. Now, whatever electricity is, it is a swift carrier of heat. We have motive power converted into current, and then we can have current converted into motive power. For example, Sir William Armstrong has his electric light worked by a water wheel.

The great advance on Faraday's spark of 1831 as to practical use, is the use of a cheap fuel—coal—for obtaining through the steam-engine the motive force required. All the various modifications of the light as now used depend on this.

Professor Tyndall gave a historical sketch of the various arrangements, beginning with that of Mr. Holmes in 1862. The various "candles" in use were also described. Professor Tyndall said he did not believe any fresh scientific discovery was needed to make the electric light of general application to large places. The scientific man knew what different natures of machines were required to do the different kinds of work to be done. It remained now for mechanical skill to carry out the work. In conclusion, he pointed out the mistake of those who, like Cuvier, spoke with contempt of those whose practical skill carried to utility the experiments of the philosopher.

The Writing Telegraph.—Autographic telegraphy, or the process of transmitting messages in the actual handwriting of the sender, has occasionally during the past thirty years constituted the special study of scientific minds. So long since as 1850 Mr. F. C. Bakewell invented a copying telegraph, by means of which autographic telegraphy was effected, and this was probably the first time it was effectually accomplished. In this instance the message was written by the sender with a gummy ink or varnish on metallic paper or tin foil, and this writing was by the aid of mechanism used to actuate electric currents in such a way as to produce a record at the distant station by the chemical decomposition of a solution with which the receiving paper was damped. Both the written message and the paper were fixed around cylinders of similar form and dimensions, one being placed in the transmitting and the other in the recording instrument and the cylinders were caused to revolve with corresponding velocities. Each time the gummy and, consequently, raised lines of the writing were crossed by a pointer, under which the metallic paper was traversed in the transmitter, a mark corresponding in position was made on the prepared paper at the receiving end. It therefore followed that the sum of all the marks reproduced the writing itself. Mr. Bakewell successfully reproduced the writing in white on a blue ground, but the process failed to become of public utility owing to the extreme slowness with which the apparatus worked, and the difficulty that was experienced in

maintaining uniform and syncronous motion in the instruments.

In 1856, the Abbé Caselli, in Italy, endeavoured to solve the problem of autographic telegraphy in a similar manner. His apparatus was exhibited in England, and it was used practically between Paris and Marseilles and Paris and Lyons. Plans, drawings and autograph sketches were faithfully reproduced at distant places, but it was found that the apparatus had not only the defects of Bakewell's, but it was very costly and complicated.

Two other subsequent workers in this direction were M. Meyer and M. Lenoir, who tried to accomplish the same results with ordinary ink. They, however, pursued their investigations quite independently of and unknown to each other.

We have recently been afforded the opportunity of examining the latest example of this class of apparatus at the General Post Office, where it has been submitted to the authorities for trial. This is the invention of M. d'Arlincourt, of Paris, and its general principles are similar to those which govern Bakewell's system. The distinguishing feature in D'Arlincourt's apparatus, however, is the introduction of an extremely ingenious synchronous movement, by means of which the speed of travel of the cylinders is rendered uniform, both in the transmitting and the recording machine. The message to be sent, which may be either in the ordinary hand or shorthand, is written with a thick gummy ink upon a strip of metallic-faced paper about 12 in. long and 2½ in. deep, which is wrapped around the cylinder of the transmitting instrument. A strip of white paper, chemically prepared and of similar dimensions, is placed on the cylinder of the recording apparatus, and the instruments are placed in electrical connection and started. The raised writing, actuating the electric current, causes a reproduction of the original message in facsimile on the paper in the recording instrument, which may be hundreds of miles away from the other.

The writing can be reproduced in either blue, brown, red, or black, according to the chemical preparation of the paper, but always on a white ground, and a number of copies can be taken from one original. In the same way, sketches, plans, or drawings may be faithfully transmitted. Although the apparatus is perfect in its action, it still has one drawback, which was common to its predecessors—that of slowness of reproduction. The time occupied in revolving the cylinder a sufficient number of times to allow the pointer to traverse the whole surface of the paper is seven minutes, and this rate of speed is far below that required and attained in practice for commercial purposes. The Post Office authorities do not, therefore, see their way to utilise M. d'Arlincourt's ingenious invention at present. It is, however, being worked in France in fortresses, and for similar military purposes, for use in which and in some special cases it is exceedingly well adapted.

Another Writing Telegraph.—Mr. E. A. Cowper read a most in-

teresting paper before the British Association on his "Writing Telegraph." He described the details of the construction of his writing telegraph, and the mode in which a pen at a distant station was made to write freely as the operator at the sending station wrote with a pencil at the sending instrument. He explained the necessity that existed for causing the two currents of electricity that conveyed the power to the distant station to increase steadily and gradually, without any sudden large increase or decrease of resistance being opposed to such currents, the construction of the necessary resistances being practically that of one very long thin German silver wire having 32 metal plates soldered to it at the proper intervals, such plates being all brought very close together, with simply a thin sheet of paper with paraffin between them, so that a contact rod in connection with a battery, with a small knob or projection on it, could slide over the tops of the plates and make contact with each one in succession. Then two such contact rods, jointed to the pencil of the operator, and placed at right angles to one another, worked over the tops of the two separate sets of contact plates, each set affecting one line of wire so as to give the latitude and longitude of the pencil of the operator at all times. The quick action of the perfect response of the needles at the receiving instrument, which directly controlled the writing-pen, was obtained by using exceedingly thin soft iron plates, both for the needles and for the magnets which affect the needles, so as, on the one hand, to have the least possible amount of momentum and *vis inertiæ* in the needles, and the least possible residuary magnetism in the magnets. The needles were slightly curved in their section to stiffen them, their thickness being only 1·110 inch, and were mounted on polished hard steel bearings, and were then exceedingly fresh and lively, as a very small amount of friction or weight in this part of the instrument would be fatal to good writing. The power of the needles was insured by fixed flat coils that surrounded them, brought into action by a local battery, while the two line wires were coiled round the fixed magnets. That affected the needles, and attracted them more or less as the strength of the current varied. Then the needles, being at right angles to each other, pulled the pen in the two directions, vertically and horizontally, and also pulled against two light springs, so that the pen took exactly the varying positions due to the varying strengths of the currents, which, again, depended on the positions of the operator. The paper on which the operator wrote, and the paper on which the pen wrote at the opposite end of the line, both moved along by clockwork, so as to write with remarkable regularity, a long continuous message or telegram.

VIII.—CHEMISTRY.

The Presence of Nitrogen in Steel.—Mr. A. H. Allen read a paper on this subject, before the British Association, in which he remarked that whether nitrogen is a normal constituent of steel is a question which has been attacked by many investigators. One of the most recent researches was that made in 1864, by Messrs. Stuart and Baker, who concluded that nitrogen was not an essential constituent of steel. Their method of research was very strongly criticised, and their experiments have generally been regarded as inconclusive.

The author made some preliminary experiments on the subject in 1872, but has only recently obtained any definite results. The method adopted has been to dissolve the steel in hydrochloric acid, by which means any combined nitrogen may be presumed to be converted into ammonia. The solution obtained was then distilled with excess of lime, and the distillate examined for ammonia by Nessler's method. The employment of this extremely delicate test enabled the author to operate on a much smaller quantity of steel than was employed by previous investigators. Very special precautions were taken to obtain the hydrochloric acid and other materials free from any traces of ammonia or nitrous compounds, and the air was entirely expelled from the apparatus before commencing the operation. The hydrogen evolved was freed from any traces of ammonia by passing it through a tube filled with glass beads moistened with hydrochloric acid. It was proved by several experiments that no source of ammonia existed in the reagents or the apparatus. When absolutely pure materials were used and every precaution taken to get rid of the contained air and other sources of error, the addition of Nessler's solution to the liquid obtained on distilling with lime caused a very marked yellowish-brown colouration.

On comparing the tint produced with that yielded by a dilute solution of ammonium chloride of known strength, the following results were arrived at, as the proportions of nitrogen present in various typical specimens of steel:

	Nitrogen present. Expt 1.	Expt. 2.
1. Bessemer (Phœnix Works)	·0107	
2. Ditto . .	·0107	
3 Ditto (Atlas Works)	·0148	
4. Siemens Marten	·0063	
5. Blister (Steinbuck)	·0086	·0094
6 Blister	·0090	·0086
7. Double Shear	·0078	
8. Crucible cast (Jessop)	0049	·0049
9. Ditto (Britain)...	·0049	
10. Pianoforte wire	·0020	

The author regards the results now recorded as preliminary merely, and proposes to extend the researches to various classes of steel and iron, and especially to such specimens as have been found to possess anomalous characters.

Of these characteristics the evolution of ammonia from freshly fractured surfaces is the most striking.

The Nature of the Elements.—At a crowded meeting, such as is seldom witnessed, of the Royal Society, in December, 1878, Mr. J. Norman Lockyer, F.R.S., read a lengthy paper, in which he discussed the evidence derived from spectroscopic observation of the sun and stars and from laboratory experiments, which has led him to the conclusion that the so-called elements of the chemist are in reality compound bodies.

In order that the line of argument followed by Mr. Lockyer may be understood, it will be necessary briefly to refer to the results of previous researches. As a rule, in observing spectra the substance to be examined is volatilized in a gas flame or by means of sparks from an induction coil, and the light is allowed to fall on the slit of the spectroscope; the spectrum is then generally one in which the lines run across the entire field, but by interposing a lens between the spark apparatus and the slit of the spectroscope, Mr. Lockyer was enabled to study the various regions of the heated vapour, and thus to establish the fact, already noted by some previous observers, but to which little attention had been paid, that all the lines in the spectrum of the substance volatilized did not extend to equal distances from the poles. He then showed by the aid of this method that, in the case of alloys containing different proportions of two metals, if the one constituent were present in very small quantity its spectrum was reduced to its simplest form, the line or lines longest in the spectrum of the pure substance alone appearing; but that on increasing the amount of this constituent, its other lines gradually appeared in the order of their lengths in the spectrum of the pure substance. Similar observations were made with compound bodies. It was also noticed that the lines furnished by a particular substance varied not only in length and number, but also in brightness and thickness according to the relative amount present.

Armed with these facts, and with the object of ultimately ascertaining more definitely than has hitherto been possible which of the elements are present in the sun, Mr. Lockyer, about four years ago, commenced the preparation of a map of a particular region of the spectra of the metallic elements for comparison with the map of the same region of the solar spectrum. For this purpose about 2,000 photographs of spectra of all the various metallic elements have been taken, and, in addition, more than 100,000 eye observations have been made. As it is almost impossible to obtain pure substances, the photographs have been carefully compared, in order to eliminate the lines due to impurities; the absence of a particular element as impurity being regarded as proved if its longest and strongest line was absent from the photograph of the element under examination. The result of all this labour, Mr. Lockyer states, is to show that the hypothesis, that identical lines in different spectra are due to impurities, is not sufficient; for

he finds short line coincidences between the spectra of many metals in which the freedom from mutual impurity has been demonstrated by the absence of the longest lines. He then adds that, five years ago, he pointed out that there are many facts and many trains of thought suggested by solar and stellar physics which point to another hypothesis—namely, that the elements themselves, or, at all events, some of them, are compound bodies. Thus, it would appear that the hotter a star the more simple is its spectrum; for the brightest, and therefore probably the hottest stars, such as Sirius, furnish spectra showing only very thick hydrogen lines and a few very thin metallic lines, characteristic of elements of low atomic weight; while the cooler stars, such as our sun, are shown by their spectra to contain a much larger number of metallic elements than stars such as Sirius, but no non-metallic elements; and the coolest stars furnish fluted band spectra characteristic of compounds of metallic with non-metallic elements and of non-metallic elements. These facts appear to meet with a simple explanation, if it be supposed that as the temperature increases the compounds are first broken up into their constituent "elements," and that these "elements" then undergo dissociation or decomposition into "elements" of lower atomic weight.

Mr. Lockyer next considers what will be the difference in the spectroscopic phenomena, supposing that A contains B as an impurity and as a constituent. In both cases A will have a spectrum of its own. B, however, if present as an impurity, will merely add its lines according to the amount present, as we have above explained; whereas, if a constituent of A, it will add its lines according to the extent to which A is decomposed and B is set at liberty. So that as the temperature increases the spectrum of A will fade if A be a compound body, whereas it will not fade if A be a true element. Moreover, if A be a compound body, the longest lines at one temperature will not be the longest at another.

The paper chiefly deals with a discussion from this point of view of the spectra of calcium, iron, hydrogen, and lithium as observed at various temperatures; and it is shown that precisely the kind of change which is to be expected on the hypothesis of the non-elementary character of the elements has been found to take place. Thus, each of the salts of calcium, so long as the temperature is below a certain point, has a definite spectrum of its own, but as the temperature is raised the spectrum of the salt gradually dies out, and very fine lines, due to the metal, appear in the blue and violet portions of the spectrum. At the temperature of the electric arc the line in the blue is of great intensity, the violet H and K lines, as they are called, being still thin; in the sun the H and K lines are very thick, and the line in the blue is of less intensity than either, and much thinner than in the arc. Lastly, Dr. Huggins's magnificent star photographs show that both the H and K lines are present in the spectrum of *a* Aquilæ, the latter being, however, only about

half the breadth of the former; but that in the spectrum of *a* Lyræ and Sirius only the H line of calcium is present. Similar evidence that these different lines may represent different substances appears to be afforded by Professor Young's spectroscopic observations of solar storms, he having seen the H line injected into the chromosphere 75 times, the K line 50 times; but the blue line, which is the all-important line of calcium at the arc-temperature, was only injected thrice. In the spectrum of iron, two sets of three lines occur in the region between H and G, which are highly characteristic of this metal. On comparing photographs of the solar spectrum and of the spark taken between poles of iron, the relative intensity of these triplets is seen to be absolutely reversed; the lines barely visible in the spark photograph being among the most prominent in that of the solar spectrum, while the triplet, which is prominent in the spark photograph, is represented by lines not half so thick in the solar spectrum. Professor Young has observed during solar storms two very faint lines in the iron spectrum near G injected 30 times into the chromosphere, while one of the lines of the triplet was only injected twice. These facts, Mr. Lockyer contends, at once meet with a simple explanation if it be admitted that the lines are produced by the vibration of several distinct molecules.

The lithium spectrum exhibits a series of changes with a rise of temperature precisely analogous to those observed in the case of calcium.

In discussing the hydrogen spectrum, Mr. Lockyer adduces a number of most important and interesting facts and speculations. It is pointed out that the most refrangible line of hydrogen in the solar spectrum, *h*, is only seen in laboratory experiments when a very high temperature is employed; and that it was absent from the solar protuberances during the eclipse of 1875, although the other lines of hydrogen were photographed. This line, also, is coincident with the strongest line of indium as already recorded by Thalèn, and may be photographed by volatilizing indium in the electric arc; whereas palladium charged with hydrogen furnishes a photograph in which none of the hydrogen lines are visible. By employing a very feeble spark at a very low pressure the F line of hydrogen in the green is obtained without the blue and red lines which are seen when a stronger spark is used, so that alterations undoubtedly take place in the spectrum of hydrogen similar to those observed in the case of calcium. In concluding this portion of his paper, Mr. Lockyer states that he has obtained evidence leading to the conclusion that the substance giving the non-reversed line in the chromosphere, which has been termed *helium*, and not previously identified with any known form of matter, and also the substance giving the 1,474, or coronal line, are really other forms of hydrogen, the one more simple than that which gives the *h* line alone the other more complex than that which gives the F line alone.

There can be no question that

the facts brought forward by Mr. Lockyer are of the highest importance and value, and that they will have much influence on the further development of spectrum analysis, to which he has already so largely contributed. But his arguments are of a character so totally different from those ordinarily dealt with by chemists, that they will hesitate for the present to regard them as proof of the decomposition of the elements until either they are assured by competent physicists that they cannot be explained by any other equally simple and probable hypothesis, or until what Mr. Lockyer has foreshadowed as taking place to such an extent in other worlds has been realized beyond question or cavil in our own laboratories.

It has been suggested that the same molecule may be capable of vibrating in different ways at different temperatures, and thus of yielding different spectra, just as a bell may give out different notes when struck in different ways; and although Mr. Lockyer has replied to this objection, it can scarcely be regarded as finally disposed of. The fact, however, as Mr. Lockyer has pointed out, that the change from the spectrum of a compound to the lowest temperature spectrum of its metallic element, is of a similar character to, and even less in degree than, the change from the lowest temperature spectrum of the metal to the spectra which it furnishes at higher temperatures, does not appear to favour such an hypothesis, and from the similarity in the phonomena it is difficult to deny that in both cases decomposition does not equally take place. Professor Young's observations on the injection of particular lines into the chromosphere during solar storms are also difficult to reconcile with this view, and if the conclusions drawn from previous researches are correct, it also does not account for the short line coincidences which led Mr. Lockyer to his hypothesis.

Chemists are careful to teach that what are at present regarded as elements are not necessarily simple bodies, but merely substances which they are unable to decompose, or which they have no special reason to regard as compound bodies. The remarkable relations, both in atomic weight and properties, existing between many of the elements tend, indeed, to show that they are related in the manner Mr. Lockyer supposes.—*Times*.

It is sufficient to say that each print is procured by the action of light on a gelatine film impregnated with bichromate of potash, which renders the coloured gelatine more or less insoluble. When the soluble portions are washed away the print remains ready for transfer to paper. On the same principle it is that the initial print for the Woodbury-type process is secured, though the basis of paper is replaced by a collodion film. Thus it appears that the advances made in printing processes are all due to the knowledge of the change effected on bichromates when in contact with colloidal substances, a knowledge which we owe to the researches of Mungo Ponton, though elaborated by Poitevin and other distinguished workers in the same field.

The execution of photographically engraved plates and relief blocks in metal has long been a desideratum, and more than twenty-five years ago we read of attempts being made to render it practicable. With Nièpce's original photographic process with bitumen the greatest measure of success has been obtained, as with it it is practicable to form an acid-resisting image on a metallic surface. This surface can then be etched to the required depth, the bitumen image protecting the necessary portions, and prints can be pulled from it in the ordinary manner. Other methods are based on the production of electrotypes from gelatine images, and meet with great favour in some quarters; for instance, the beautifully executed maps of the Austrian Government are believed to be produced in this manner. Every day, indeed, these photographic blocks and plates are coming more into use commercially; in America we find weekly and even daily journals largely illustrated by cuts photographically reproduced, and some of our own periodicals indulge in them to an extent which an adept can discover is by no means limited.

In the facilities offered for taking photographic negatives also, we have had a remarkable advance through the introduction of what are technically called the "emulsion" processes, which for rapidity and delicacy of image rival the old wet plates, and for simplicity entirely distance it. A photographic emulsion consists of a highly sensitive silver compound held in suspension in collodion or gelatine. When in the former, a glass plate has merely to be covered with a film of the fluid and then allowed to dry in the dark, when it is ready to receive and retain an impression of the image optically formed in the camera. When in the latter, though the manipulations for preparing the plate are rather more prolonged, yet, when finished, we have a surface which is sufficiently sensitive to be impressed by objects illuminated by lamp or gas light. For the amateur the nitrate of silver bath and its inconveniences are banished from the laboratory; and the stained fingers and clothes arising from the ordinary mode of bringing out the image on the surface are avoided by employing the alkaline method of development discovered by Major Russell some

years ago. The load that the landscape photographer has to carry in the field, has also been diminished by applying this emulsion to long bands of impervious paper, by which plan material for the reception of one hundred impressions can be carried with less inconvenience than half a dozen glass plates. To Woodbury and Warnerké the credit of this invention is due, which would have been incomplete and in no way superior, except as regards rapidity, to the old waxed paper processes, had not the latter shown us how the developed film could afterwards be transferred to glass for printing purposes. To the traveller unacquainted with the practical operations of photography, this invention is doubly useful, as a band of this sensitive paper can be transmitted by post, and the images impressed on it, perhaps thousands of miles away from home, can, on arrival, be converted into ordinary negative pictures, provided only that the duration of exposure to the lenticular image has been sufficient.

It is, perhaps, as a handmaid to science that photography gains its greatest lustre; for, though a science in itself, it is chiefly in connection with chemistry and physics that it obtains the fullest recognition. Artists in public affect to despise it, though in private it has become an invaluable aid to them; but scientists are always ready to acknowledge its utility, hence to science rather than to art it has to look for due acknowledgment of its claims. A quarter of a century ago photography was the nursling of such men of genius as Sir John Herschel, Becquerel, and Draper; and as phenomenon after phenomenon was discovered it attracted a large share of attention from the scientific world; but when the collodion process of Archer was announced and practically introduced, and it became open to the meanest intellect, it was deserted by our great thinkers, and as a science made but little progress till recently.

A revival of the interest which once existed in its growth in this respect occurred some three or four years ago, when Dr. Vogel and Captain Waterhouse demonstrated that there are fields for exploration in it yet open to him who might wish to work. They showed that the yellow and green rays of light, which were ordinarily supposed to have no chemical action on the most sensitive silver compounds, could be utilized for obtaining photographic impressions, by staining the collodion film with different aniline dyes. Following their steps, Captain Abney has shown that not only all the visible radiations can make an impression on a simple silver compound, but that the dark rays of low refrangibility, the existence of which was previously known solely by their thermal effects, can be similarly effective when the simple compound is so prepared as to absorb these radiations. Here we have a possibility of extending our knowledge of spectrum analysis, as we shall presently show, and of solving problems which heretofore were impossible to grasp. Another advance in deciphering the work written by light has also been made, which sets at rest

the notion that existed regarding the properties of the red and the blue rays of the solar spectrum. Draper had noticed, and Herschel had confirmed the fact, that the former had apparently the property of undoing the work which had been performed by the latter on the sensitive silver compound—iodide of silver, with which photographers are familiar; that is to say, if a picture were taken with the blue rays, or with white light, and then were exposed to the action of pure red light, the work of the first-mentioned rays would be undone. Thus Claudet found that a red sun was photographed as a black object against a white sky, notwithstanding the sky itself intervened between his lens and the sun. This antagonism of the different components of light remained a mystery till quite recently, when Abney was able to show that the phenomenon was due to the oxidation of the compound, which had been altered by the blue or white light, such oxidation preventing the development of the photographic image. The outcome of this last solution may, perhaps, have important results, as we find that photographs in natural colours may be produced by this process of oxidation, and if it be only possible to render them permanent, the long sought-after Eldorado will be reached.

Such is a brief outline of the progress made in the science of photography itself; but the applications of it to other branches of science are very numerous, though we can but recount a few. In solar physics we find it employed at the Physical Observatory of Meudon, near Paris, by Janssen, on a larger scale than has hitherto been attempted. In his photographs of the sun, exhibited last year before the British Association, we find its surface shown of the enormous size of 12 in. for a diameter, with details of structure which have never before been seen by the eye. These magnificent records of our luminary are due to the skill of Janssen in modifying existing processes for his purpose, to perfection in the telescope employed, and to the minute fraction, 1-3000th it is said, of a second during which the image is impressed. In these pictures we can trace the movement of the solar tornadoes in the photosphere by the obliteration of its definite structure, the very form of which would have remained open to doubt had visual observation alone been open. The telescope, it is true, when armed with a high-power eyepiece, shows the mottled appearance of the solar surface, but the area in the field of view at one time is limited, owing to the necessary magnification, and we should never have learnt by it that these solar storms were aught but the speculations of the theorist. In the photograph we are able to examine the surface as a whole, and to follow the track of the disturbances at our leisure. With the eye we integrate the solar atmospheric disturbances which occur in about the 1-10th of a second, in the photograph we have an integration for the 1-3000th of a second; visual observations are evidently, therefore, heavily handicapped compared with the photographic. For many years past we have had

smaller photographs of the sun produced at Kew and Greenwich by the aid of De La Rue's photoheliograph, with the view of obtaining an accurate register of the sizes and form of the solar spots, which wax and wane and wax again in number about every ten and a half years. If famines and want of rainfall have anything to do with the absence of sun spots, and it seems more than probable from statistics that they have, it is principally to the photographs we must look to furnish the proof, and by them the theory must stand or fall. The establishment of a small observatory in India, where the sun is more frequently seen than it is in England, for the purpose of obtaining auxiliary photographs to those at home, is a step taken in the cause of science, and in all probability for the benefit of humanity.

The same form of instrument with which these smaller photographs are taken was employed by the English expeditions for recording the transit of Venus over the solar disc, and though the parallax obtained by photography has not proved to be as satisfactory as it was hoped, yet the fact of its employment at all marks the value set upon its aid by astronomers. In the recent total solar eclipse visible in America, it again obtained recognition as a recorder of facts in contradistinction to the eye. which is sometimes a recorder of foregone conclusions, and we find that no party of observers was complete without its camera and its photo-spectrograph.

Turning to another important and rapidly growing branch of physics, we must note its adaptation to spectrum analysis, in which Draper, Lockyer, Vogel, and Cornu, among others, have given it full employment as regards the sun, and Huggins as regards stellar work. During the last few years some of the most important advances in solar analysis have been made by its aid. Thus we find that Cornu has mapped the ultra violet region of the spectrum, and in that portion bordering on the region of visibility Lockyer has been able to lay down hundreds of those dark Fraunhoffer lines which cross the spectrum and tell us of the constitution of the sun, while visually the number might be reckoned as units. Not that the absolute number is so important, as the fact that some of the new ones mapped disclose the existence of elements in the solar atmosphere which before were more than doubtful. Again, too, in the spectrum photographs a leisurely study can be made of the relative thickness and darkness of these Fraunhoffer lines, and the constitution of the upper and lower layers of the photosphere be approximately determined. It seems probable that even in our own day a change in their condition has occurred, since the relative blackness of certain lines has apparently altered. In future years the testimony of our photographs will be more valuable than the records of one hundred eye observations.

We cannot do more than give a passing allusion to Lockyer's great discovery of the long and short bright lines of the spectra of

metallic vapours and their connection with the spectrum analysis of the sun, and the possibility of reducing each of the spectra to one distinctive line, or monochromatic colour, in all of which photography has played an important part. By photographing the dark regions of the solar spectrum of low refrangibility, we may hope to know more regarding the state in which some of the metals exist in photosphere, since experiments made with the electric arc have shown that if they do so as compounds their spectra will partially lie in this part. Huggins, in his photographs of stellar spectra, shows records of the truth of the dictum that we have hot and cold stars planted in the heavens, and possibly they may tell us a good deal more than this as our familiarity with them increases and as our means of interpretation grow. To Francis Galton we are indebted for a totally novel application of photography to scientific research. By taking photographic portraits of our gaol-birds, and then building up a picture with the photographs of convicts imprisoned for the same class of offence, he is able to show us the type of face and head from which we may expect the commission of any particular crime. Or, again, by taking the photographs of a family, and giving a certain value to collateral branches, he is able to build up a typical family face. The combination of these portraits, we may remark, is effected by printing the camera pictures on the same paper for different lengths of time. Thus, the son's portrait might have three minutes' exposure to light given to it; this camera picture would be withdrawn, and a paternal uncle's superposed for one minute, and so on, till the whole family had contributed to make the typical face. Some of the results obtained are immensely striking. we doubt not that much more may be learnt by adopting this or some other similar method for the purpose. At Greenwich, and at other meteorological observatories, we have long had photography employed as the register of the slow variations indicated by various meteorological instruments, but to-day we find it put into requisition for the registration of quick oscillations. The vibrations made by the disc of the telephone, the movements of the pulse, the forms of beats—all of them are now recorded by it; and we might indicate other branches of science where the rapidity of the impressions made would be of immense value.

In our military services we have it employed as a measurer of the force of torpedoes, by registering the height and dimensions of the volume of water raised, or as a reconnoitrer from a balloon. At the siege of Paris we all recollect the pigeon post, and the use that was made of it for sending despatches and letters in miniature; but we shall be surprised if in a future war photography is not used more extensively than at present the public think possible. Our list might be lengthened out if space permitted; but we have, we think, shown sufficiently that photography progresses in itself and in its applications, that it is a scientific industry as well as a

science, and that its future is not a contracted one, but universal in its character. Light must become the pen of the man of science, the pencil and colour-box of the artist, and the tool of the engraver.—*Times.*

Chinese Straw-Plaiting and Straw Hats.—In the province of Shantung, in the east of Honan, and in the south of Chi-li, the production of straw textures forms an important occupation for men, women, and children. The product of Chi-li is brought to Tientsin, that of Shantung and Honan to Cheefoo, for sale. In both places fine qualities are distinguished. The plaits are packed in bales of 240 bundles, which in Tientsin contain from 60 to 66 yards, in Cheefoo 35 to 102 yards. The price varies in Tientsin between 22 and 50 taels, in Cheefoo between 17 and 70 taels per bundle. The whole quantity produced is sent from Cheefoo or Tientsin to Shanghai, and thence is exported to the United States and England. About one-fifth of the quantity exported finds its way to England on account of the low freight; this is distributed over the United Kingdom to the various centres of consumption, to France, Switzerland, and the United States. The Chinese straw-plaiting is specially used in the manufacture of hats, and, in more recent times, straw baskets and similar articles are made out of it. The Customs statistics show not only a steady increase in the quantities exported, but also a remarkable rise in the price of this article, which is mainly due to its more careful manufacture. For about ten years between 1,000 and 3,000 piculs were exported, and the trade with foreign countries in this production was scarcely noticeable. A part of the production went to Canton, and was there manufactured into hats, which were then exported. Since then this industry has waned, and the raw material—*i.e.*, the straw-plait itself—is more and more sent out of China. Thus the export of the latter rose from 2,815 piculs in 1871 to 13,446 piculs in 1872. The year 1873 again showed a falling off (11,892 piculs). Since 1874 the increase has been steady. The variations in price were very great; towards the end of 1877 the quotations were 30 per cent. higher than at the beginning of the year. Besides straw-plaiting, the straw hats of Ningpo are of some importance in foreign trade. Of these hats various qualities are made, which vary in price between 14 and 40 taels per 1,000. The export is mainly to the United States and England. The best sorts are bleached in France and Switzerland, and sold as an imitation of the Panama hats.

XI.—ASTRONOMY.

The Distribution of Stars in Space.—This subject, studied much by Herschel and others, has fresh light thrown on it from observations recently communicated to the Lombardy Institute of Science and Literature, by Signor Celoria, who in 1873-76 carried out a series of star enumerations at the Milan Observatory, with a Plössl equatorial, giving very distinct images, and, in a good atmosphere, showing stars even of the 11th magnitude. The part of the heavens examined comprised 6 deg. in declination northwards from the equator, and was divided into 21 zones, and these again into small plots of 10 minutes in right ascension, which were in turn carefully examined. (Declination and right ascension correspond to latitude and longitude on the earth.) The discussion of the tabulated numbers, along with previous researches, leads to interesting results. There are, the author states, two rings of Milky Way, inclined to each other at an angle of 19 to 20 degrees, in which all visible stars are grouped. The one ring extends from the stars near us, rises gradually in space, containing, in the regions about the 19th hour of right ascension, stars of greater, but not *maximum*, distance. The other ring surrounds and contains the first; it consists of generally more distant stars, but about the sixth hour of right ascension it contains relatively nearer stars, and passing out of this it rises into space, reaching its point of culmination at the beginning of the 19th hour of right ascension, where Herschel got the largest numbers, and where are also the greatest depths. Whether the two rings remain quite separate at the parts where they cross each other, or combine into one system, cannot be determined.

It further appears that the middle lines of the two rings do not follow a large circle of the celestial vault, but a small one; that the sun is not contained in the plane of either ring, and that it is eccentric to them, towards the constellation of Virgo. The regions in which the star densities are greater than the mean density are two in number, and especially in the case of the more distant stars present sharply marked limits: there is no gradual transition, but a sudden change. As on our coasts a stretch of coast-line suddenly trends inward, so in the richer regions of Milky Way, especially near the 19th hour, the star densities suddenly increase, and the stars become quickly removed to greater distances in space. For no magnitude of stars is there any regular distribution observable. The *minima* of the stars are found in almost diametrically opposite regions, which are distant six hours' right ascension from the dense regions.

The Direct Motion of Periodic Comets.—Professor H. A. Newton (Yale College, U.S.) read a paper before the British Association on "The Direct Motion of the Periodic Comets of Short Period," which he illustrated with diagrams. The periodic comets, or comets certainly seen at two returns, were twelve or fifteen in number, and had all, but one or two, small inclinations to the ecliptic. This direct motion of the periodic comets suggested for them an origin common in some way with the origin of the planets. The other comets apparently came to us from outside the solar system; and if in any cases they were permanent members of the solar system, they had become such by the perturbations of the planets. If an indefinitely great number of comets approach and pass a large planet, and if the directions and lines of motion are uniformly distributed, some of them coming near to the planet will be turned into orbits of short period, or form those having parabolic orbits. He concluded that, because of their direct motions, he was not required to consider them as differing in genesis from those of long period. This conclusion suggested the possibility of a common outside origin to the periodic comets and the asteroids.

The Phenomena of the Glacial Age Accounted for.—Professor Langley, of the Allegheny Observatory, is of opinion that the atmosphere of the sun is proved to be a thin stratum which cuts off one-half of the heat that would otherwise reach the earth. He calculates that if this envelope should be thickened twenty-five per cent., the mean temperature of our globe would be reduced one hundred degrees Fahrenheit; and he suggests that such a thickening would account for the phenomena of the glacial period.

The Extreme Limits of the Solar Spectrum.—The extreme limit of the solar spectrum in the ultra-violet has been an object of study to M. Cornu of late; an exact knowledge of this, or rather of the law according to which the intensity of the ideal continuous spectrum of the photosphere diminishes, being calculated to throw some light on the temperature of the sun. Unfortunately, he finds that the atmosphere exercises such powerful absorption on the radiations of short wave-length, that the greater part of the ultra-violet spectrum is intercepted suddenly and completely. Still, M. Cornu's results are not without interest. The limit of the spectrum is variable with the state of the atmosphere, the kind of collodion used, and the duration of exposure; but, keeping the latter two constant, and operating on very fine days, comparable observations may be had. It is shown that the extent of the spectrum diminishes with the (diminishing) height of the sun, proving the fact of atmospheric absorption.

The furthest limit M. Cornu got was that corresponding to wave-length 293; this occurred certainly twice on 24th June and 18th August, 1878, about midday. The limits 294 and 295 were got several times in May to September. M. Cornu inquires to what extent the limit might be pushed back if one were to seek

more favourable conditions, *e.g.*, by rising in the atmosphere, and so diminishing the thickness of the absorbent layer. He finds that, by rising 663·3m., the limit is extended only one-millionth of a millimetre in the wave-lengths. Thus 4,000 metres (beyond which one could hardly make regular observations) would give only six-millionths mm., or about half the difference presented between winter and summer.

The Colours of Double Stars.—It has been proved (by English observers) that some relation exists between the solar activity and the relative positions of the members of our planetary system. And the light of planets is found to vary, both in intensity and colour, these changes being in some relation, apparently, to the orbital position of the planets. Such correlations lately suggested to M. Niesten, of the Brussels Royal Observatory, to examine whether double stars did not show something of the same kind, or whether the changes in colour of certain of these systems were not connected with the position of the companion relatively to the principal star. He has accordingly drawn up a table of colours of twenty binary groups, according to nearly a century of observations by astronomers.

The results of his inquiry are briefly these:—1. In systems with well-marked orbital motion, and especially in those of short period, the two components have ordinarily the same yellow or white tints. 2. In systems about which we have colour observations sufficient to enable us to connect the colour with the position of the satellite in its orbit, the principal star is white or pale yellow, when the companion is at its periaster (*i.e.*, nearest the principal), whereas, in the other positions, it is yellow, gold-yellow, or orange. 3. The companion follows the principal star in its fluctuation of colour, and often surpasses that in colour as it withdraws from periaster. 4. The same similarity of tints in the two stars appears both in binary groups with rectilinear motion and in those with orbital motion and long periods of revolution. 5. In perspective binary groups the companion is almost always blue. This last observation is thought to point to a superposition of tint (as in the case of distant mountains looking blue). From these groups, the small star may be reasonably supposed much further distant than the large one; in fact, near the confines of the visible world. May not this blue colour (it is asked) be due to a gaseous medium expanded in celestial space, acting on luminous rays which traverse it quite like our own atmosphere, of which it is, perhaps, merely the continuation?

The Origin of Comets.—In his theory of the development of the solar system, Kant derives the comets from the substance of the condensing solar nebula. He regards them as really planets, which, through some disturbing cause, have been forced out of their normal orbit. On the other hand, La Place, in working out his nebula hypothesis, supposes comets to be formed of matter dispersed throughout the regions of the fixed stars, and that their origin has no relation to the solar

nebula. Are we in possession of facts which may warrant a positive decision between these two theories? This inquiry has recently been studied by Professor Newton, who, in a recent number of the *American Journal of Science and Arts,* first indicates the consequences of the two theories with regard to form and distribution of the cometary paths, and then compares the actually observed paths of 247 comets. The former are represented by the author in two graphic curves, and when the results of observation are put into the same form, it is at first found that the curve thus had differs from both the theoretical ones. As, however, the known comets all have their perihelion (that part of their orbit nearest the sun) within the orbit of Mars, and are exposed to planetary disturbances, Professor Newton calculates the influence of these disturbances, and arrives at the result that the curve corresponding to the actual cometary paths is thus brought into good agreement with the theoretical curve deduced from La Place's hypothesis, whereas it does not so agree with the curve from Kant's hypothesis. Thus, the origin of comets, it seems, must be placed in interstellar space.

Eccentricities of Astronomers' Eyes.—Mr. Otto Struve, astronomer at the Imperial Observatory of St. Petersburg, has discovered that in all his observations of stars carried on during thirty-five years there is a systematic error. He has ascertained the amount of error by measurements of artificial stars, and can therefore make the necessary correction to his long series of observations. He supposes that the error has a physiological origin dependent on certain peculiarities of the eyes; and he suggests that all observers should test themselves rigorously with a view to accuracy in comparison of observations. For years past astronomers have been accustomed to allow for what they call the "personal equation" in reconciling discrepancies of observation.

The Royal Observatory.—The annual report of Professor G. B. Airy, the Astronomer Royal, for 1878–9, embraced the period of 13 lunations from the new moon of May 2, 1878, to the new moon of May 20, 1879. After a fine autumn the weather in the winter and spring had been remarkably bad. More than an entire lunation was lost with the transit-circle, no observation of the moon on the meridian having been possible between the 8th of January and the 1st of March. Neither sun nor stars could be seen for eleven days, during which period the clock times were carried on entirely by the preceding rate of the clock. The accumulated end of that time did not exceed 0·3. Photographs of the sun had been taken on 150 days, and 228 of these had been selected for preservation. The photographs showed a complete absence of spots on 121 days out of 150. The mean temperature of the year 1878 was 40·6, being 0·2 above the average of the preceding 37 years. The months of greatest duration were February and May, respectively 2·9 and 2·5 above the average, and November and December, respectively 3·3 and 6·5 below. The mean temperature was above the

average in every month except September, November, and December. The highest temperature was 85° on the 26th of June, and the lowest, 12·2 on the 25th of December.

In regard to the Greenwich time-ball, there had been only one failure from accident in the automatic drop; on six days the ball was not raised on account of high wind, and on one day the mast was so thickly coated with ice that the ball could not be moved. The Deal ball was not dropped at one o'clock on seven days through failure in the telegraphic connection; on two days the ball was accidentally dropped about two seconds too soon by telegraph signals; on 17 days the current was weak, and the trigger was released by the attendants without appreciable loss of accuracy. On the nine days of failure of the ball drop at one o'clock a black flag was hoisted, and the ball was dropped at two o'clock. The Westminster clock had not been quite so well regulated as usual. During the period to which the report referred its error exceeded 1 sec. on 77 days; on 15 of these it was between 2 sec. and 3 sec., on four between 3 sec. and 4 sec., and on one day it exceeded 4 sec.

An Astronomical Dome of Paper. — Professor Greene, of Troy, State of New York, having to superintend the erection of an astronomical observatory, decided that the dome should be made of paper, with a view to avoid the heavy weight, from five to ten tons, of a dome constructed in the ordinary way, and the machinery required to revolve it. The dome in question is twenty-nine feet in diameter; paper of the best quality, one-sixth of an inch thick, was made expressly for the purpose, and fitted in sections to the wooden framework. The structure (of the paper) is described "as compact as that of the hardest wood, which it greatly excels in strength, toughness, and freedom from any liability to fracture." The surface is painted, and as no external nails are used, this novel roof may be expected to last many years. The total weight is about four thousand pounds, which can be revolved by hand without the use of machinery.

Meteoric Dust.—Mr. Cowper Ranyard has made a communication to the Astronomical Society on meteoric dust, in which he has thrown out some interesting speculations as to the explanation of the relative distribution of land and water on the globe, and as to geological climates. He says that meteoric dust exists to a much greater extent than was formerly suspected. In 1867 Dr. Phipson published the result of many experiments in many countries, which showed that, by exposing a sheet of glass covered with pure glycerine to a strong wind, he has collected on it black angular particles, which he has by chemical tests found to be iron. It is, however, only in the winter months that he has found this to be the case. In 1871 Dr. Nordenskjöld collected by a magnet meteoric iron particles from snow which had fallen near Stockholm. In 1872 he collected much of it from snow lying on ice in Finland. The Arctic Expodition of 1872 had opportunities of collecting snow far removed from human habita-

tions, and they found large proportions of magnetic particles.

M. Tissandier, in 1874–5–6, published in the *Comptes Rendus* a series of papers on atmospheric dust, in which, among other things, he has alluded to the iron found in the dust collected on the towers of Notre Dame. Again, Dr. Walter Flight published in the *Geological Magazine* in 1875. a paper in which he collected the evidences of iron "dust" found in holes in the ice in Greenland. In 1876 Mr. John Murray published a paper in the "Proceedings of the Royal Society of Edinburgh," in which he gave an account of his examinations of the bottom of the oceans and seas visited by Her Majesty's ship "Challenger." In many of the deposits magnetic particles were found. It was suggested that the nickel present prevented oxidization, while the fact that the meteoric particles which had fallen into the sea had not been washed away was attributed to the water being deep, and not near the scourings of land surfaces which would cover it up. Again, in 1876 M. Yung examined the iron particles found in the snow which had fallen at the Hospice of St. Bernard.

Mr. Ranyard submits that all these facts go to show that meteoric matter falling in the lapse of ages must materially contribute to the matter of the earth's crust. In the course of a year millions of meteors enter the earth's atmosphere. Most of them are "consumed" in the higher regions, but many particles reach the earth without having undergone change. There is little doubt that high above the earth's surface the air is impregnated with dust. The researches of Von Niessl show that many of the meteoric masses enter the earth's atmosphere in directions indicating that they do not belong to our solar system. It is therefore probable that a large quantity of meteoric dust is derived from sources outside our system. The earth and the planets, as they are carried along with the sun in its motion through space, would thus receive a larger proportion of meteoric matter on their northern than on their southern hemispheres, and Mr. Ranyard suggests that this may account for the preponderating mass of the continents in the northern hemisphere of the earth and for the fact that the great peninsulas all taper to the south.

Another important inference to which Mr. Ranyard directs attention is that it is known that when meteoric masses are heated large amounts of occluded gas are given off. One of the results from a continuous fall of meteoric matter is that gaseous matter is probably being continually added to the atmosphere. According to whether the earth were passing through a region of space in which there are many or few meteors, the height of the atmosphere would be increased or decreased. When decreased, the temperature at the sea level would be that of our mountain tops, and a glacial period would result. When increased, the temperature would probably be like that of the carboniferous period.

Sun Spots and Commercial Panics.—We are not only, it would seem, to regard the sun as the ul-

timate source of all forms of terrestrial energy, existent or potential, but as regulating in a much more special manner the progress of mundane events. Many years have passed since Sabine, Wolff, and Gauthier asserted that variations in the daily oscillations of the magnetic needle appear to synchronize with the changes taking place in the sun's condition, the oscillations attaining their *maximum* average range in years when the sun shows most spots, and the *minimum* range when there are fewer spots. And although it is well known that the Astronomer Royal in England and the President of the Academy of Sciences in France reject this doctrine, it still remains in vogue. True, the average magnetic period appears to be about 10·45 years, while Wolff obtains for the sun-spot period 11·11 years; but believers in the connection between terrestrial magnetic disturbances and sun-spots consider that among the imperfect records of the past condition of the sun Wolff must have lost sight of one particular wave of sun-spots, so to speak. If there have been 24 such waves between 1611 and 1827, when sun-spots were fewest, we get Wolff's period of 11·11 years; if there have been 25 such waves, then, taking an admissible estimate for the earliest epoch, we get 10·45 years, the period required to synchronize with the period of terrestrial magnetic changes. The matter must be regarded as still *sub judice*. This, however, is only one relation out of many now suggested. Displays of the aurora, being unquestionably dependent on the magnetic condition of the earth, would of course be associated with the sun-spot period, if the magnetic period is so; and certainly the most remarkable displays of the aurora in recent times have occurred when the sun has shown many spots. Yet this of itself proves nothing more than had been already known—namely, that the last few magnetic periods have nearly synchronized with the last few sun-spot periods. It is rather strange, too, that no auroras are mentioned in English records for 80 years preceding the aurora of 1716, and in the records of the Paris Academy of Sciences one only—that of 1666, which occurred when sun-spots were fewest. The great aurora of 1723, seen as far south as Bologna, also occurred at the time of *minimum* solar activity. Here we are not depending on either Wolff's period of 11 years or Brown's 10½ years; from records of actual observation it is known that in 1666 and 1723 there were no sun-spots. In fact, it is worth mentioning that Cassini, writing in 1671, says, "It is now about 20 years since astronomers have seen any considerable spots on the sun," a circumstance which throws grave doubt on the law of sun-spot periodicity itself. It is at least certain that the interval from *maximum* spot-frequency to *maximum*, or from *minimum* to *minimum*, has sometimes fallen far short of 9 years, and has at others exceeded 18 years.

It appears, again, that certain meteorological phenomena show a tendency, more or less marked, to

run through a ten-year cycle. Thus, from the records of rainfall kept at Oxford it appears that more rain fell under west and south-west winds when sun-spots were largest and most numerous than under south and south-east winds, these last being the more rainy winds when sun-spots were least in size and fewest in number. This is a somewhat recondite relation, and at least proves that earnest search has been made for such cyclic relations as we are considering. But this is not all. When other records were examined, the striking circumstance was discovered that elsewhere, as at St. Petersburg, the state of things observed at Oxford was precisely reversed. At some intermediate point between Oxford and St Petersburg, no doubt, the rainfall under the winds named was equally distributed throughout the spot period. Moreover, as the conditions thus differ at different places, we may assume that they differ also at different times. Such relations appear, then, to be not only recondite, but complicated.

When we learn that during nearly two entire sun-spot periods cyclones have been somewhat more numerous in the Indian Seas when spots are most numerous than when the sun is without spots, and *vice versâ*, we recognize the possible existence of cyclic relations better worth knowing than those heretofore mentioned. The evidence is not absolutely decisive; some, indeed, regard it as scarcely trustworthy. Yet there does seem to have been an excess of cyclonic disturbance during the last two periods of great solar disturbance, precisely as there was also an excess of magnetic disturbance during those periods. The excess was scarcely sufficient, however, to justify the rather daring statement made by one observer, that "the whole question of cyclones is merely a question of solar activity." We had records of some very remarkable cyclonic disturbances during the years 1876 and 1877, when the sun showed very few spots, the actual *minimum* of disturbance having probably been reached late in 1877. A prediction that 1877 would be a year of few and slight storms would have proved disastrous if implicit reliance had been placed in it by seamen and travellers.

Rainfall and atmospheric pressure in India have been found to vary in a cyclic manner, of late years at any rate, the periods being generally about 10 or 11 years. The activity of the sun, as shown by the existence of many spots, apparently makes more rainfall at Madras, Najpore, and some other places; while at Calcutta, Bombay, Mysore, and elsewhere it produces a contrary effect. Yet these effects are produced in a somewhat capricious way; for sometimes the year of actual *maximum* spot-frequency is one in which rainfall is below the average (instead of above at the former stations, and above the average (instead of below) at the latter. It is only by taking averages—and in a somewhat artificial manner—that the relation seems to be indicated on which stress has been laid.

Since Indian famines are directly dependent on defective rain-

fall, it is natural that during the years over which observation has hitherto extended the connection apparently existing between sun-spots and Indian rainfall should seem also to extend itself to Indian famines. It was equally to be expected that since cyclones have been somewhat more numerous for some time past in years when sun-spots have been most numerous, shipwrecks should also have been somewhat more frequent in such years. Two years ago Mr. Jeula gave some evidence which, in his opinion, indicated such a connection between sun-spots and shipwrecks. He showed that in the four years of fewest spots the mean percentage of losses was 8·64; in four intermediate years the mean percentage was 9·21; in three remaining years of the eleven-year cycle—that is, in three years of greatest spot-frequency the mean percentage was 9·53. Some suggested that possibly such events as the American war, which included two of the three years of greatest spot-frequency, may have had more effect than sun-spots in increasing the percentage of ships lost; while, perhaps, the depression following the commercial panic of 1866 (at a time of fewest sun-spots) may have been almost as effective in reducing the percentage of losses as the diminished area of solar maculation. But others consider that we ought rather to regard the American war as yet another product of the sun's increased activity in 1860–61, and the great commercial panic of 1866 as directly resulting from diminished sun-spots at that time, thus obtaining fresh evidence of the sun's specific influence on terrestrial phenomena instead of explaining away the evidence derived from Lloyd's list of losses.

This leads us to the last and, in some respects, the most singular suggestion respecting solar influence on mundane events—the idea, namely, that commercial crises synchronize with the sun-spot period, occurring near the time when spots are least in size and fewest in number; or, as Professor Jevons (to whom the definite enunciation of this theory is due) poetically presents the matter, that from "the sun, which is truly 'of this great world both eye and soul,' we derive our strength and our weakness, our success and our failure, our elation in commercial mania, and our despondency and ruin in commercial collapse." We have better opportunities of dealing with this theory than with the others, for we have records of commercial matters extending as far back as the beginning of the 18th century. In fact, we have better evidence than Professor Jevons seems to have supposed, for whereas in his discussion of the matter he considers only the probable average value of the sun-spot period, we know approximately the epochs themselves at which the *maxima* and *minima* of sun-spots have occurred since year 1700. The evidence as presented by Professor Jevons is very striking, though when examined in detail it is rather disappointing. He presents the whole series of decennial crises as follows:—1701 (?) (such query marks are his own), 1711, 1721, 1731-32, 1742 (?), 1752 (?), 1763,

1772–73, 1783, 1793, 1804–5 (?), 1815, 1825, 1836–39 (1837 in the United States), 1847, 1857, 1866, and 1878. The average interval comes out 10·466 years, showing, as Jevons points out, "almost perfect coincidence with Brown's estimate of the average sun-spot period." Let us see, however, whether these dates correspond so closely with the years of *minimum* spot-frequency as to remove all doubt. Taking 5¼ years as the average interval between *maximum* and *minimum* sun-spot frequency, we should like to find every crisis occurring within a year or so on either side of the *minimum*, though we should prefer perhaps to find the crisis always following the time of fewest sun-spots, as this would more directly show the depressing effect of a spotless sun. No crisis ought to occur within a year or so of *maximum* solar disturbance; for that, it should seem, would be fatal to the suggested theory. Taking the commercial crises in order, and comparing them with the known (or approximately known) epochs of *maximum* and *minimum* spot-frequency, we obtain the following results (we italicize numbers or results unfavourable to the theory):—The doubtful crisis of 1701 followed a spot *minimum* by *three* years; the crisis of 1711 preceded a *minimum* by one year; that of 1721 preceded a *minimum* by *two* years; 1731–32 preceded a *minimum* by one year; 1742 precèded a *minimum* by *three* years; 1752 followed a *maximum* by *two years;* 1763 followed a *maximum* by *a year and a half;* 1772–73 came *midway* between a *maximum* and a *minimum;* 1783 preceded a *minimum* by *nearly two* years; 1793 came *nearly midway* between a *maximum* and a *minimum;* 1804–5 coincided with a *maximum;* 1815 preceded a *maximum* by *two years;* 1825 followed a *minimum* by *two* years; 1836–39 *included* the year 1837 of *maximum* solar activity (that year being the time also when a commercial crisis occurred in the United States); 1847 preceded a *maximum* by *a year and a half;* 1866 preceded a *minimum* by a year; and 1878 follows a *minimum* by a year. Four favourable cases out of 17 can hardly be considered convincing. If we include cases lying within 2 years of a *minimum*, the favourable cases mount up to 7, leaving 10 unfavourable ones. It must be remembered, too, that a single decidedly unfavourable case (as 1804, 1815, 1837) does more to disprove such a theory than 20 favourable cases would do towards establishing it. The American panic of 1873, by the way, which occurred when spots were very numerous, decidedly impairs the evidence from the crises of 1866 and 1878.

IX.—MEDICAL.

The Effects of Breathing Noxious Vapours.—In some experiments lately made by M. Poincaré on the effects of poisoning by sulphide of carbon, he often found in the blood-vessels drops, apparently of this substance, condensed anew after absorption by the lungs. Still, the great volatility of the substance rendered this improbable *à priori*, and as he had not succeeded in chemically determining what the drops were, he hesitated to express the view referred to. He has since obtained like results with other substances not miscible with blood, and which are much less volatile than sulphide of carbon, especially spirit of turpentine and nitrobenzine. The chemical determination, indeed, was as difficult as before; but, from the fact that it was only in animals that had respired those vapours that free drops had been found in the circulation looking exactly like the substances furnishing the vapours, he thinks the matter worthy of attention. Workmen who respire vapours of this kind are evidently exposed to a poisonous action, variable with the vapour's composition, and also to mechanical disturbances of the circulation and nutrition, similar to those produced by embolies and introduction of air into the veins. Thus may probably be explained the sudden deaths observed in the course of experiment with those substances; and perhaps certain fatal results from taking chloroform have been due to the same cause. The drops in question, found in nearly all the organs, are specially abundant in the liver, the kidneys, and the lungs.

A Fragrant Stomachic.—The well-known fragrant garden favourite, the sweet-scented or lemon verbena (*Lippia citriodora*), seems to have other qualities to recommend it than those of fragrance, for which it is usually cultivated. The author of a recent work, entitled "Among the Spanish People," describes it as being systematically gathered in Spain, where it is regarded as a fine stomachic and cordial. It is either used in the form of a cold decoction, sweetened, or five or six leaves are put into a teacup, and hot tea poured upon them. The author says that the flavour of the tea thus prepared "is simply delicious, and no one who has drunk his Pekoe with it will ever again drink it without a sprig of lemon verbena." And he further states that if this be used, one need "never suffer from flatulence, never be made nervous or old-maidish, never have cholera, diarrhœa, or loss of appetite."

Different Mental Powers in the Brain.—In Dr. Busch's "Book on Bismarck," the Prince describes a horse accident he once had when riding home with his brother. He fell violently on his head. "I lost consciousness," he

says, "and when I recovered it I had only half. That is, one part of my intellect was clear and good, the other half had gone." Finding (on examination) his saddle broken, he called for his groom's horse and rode home. When the dogs there barked, by way of salutation, he thought them strange dogs, and scolded them angrily as such. Then he said the groom had fallen with the horse, and they should go and fetch him, and he became angry when they would not do that (because of a sign from his brother). He seemed to be himself and at the same time the groom. After eating and sleeping he was all right next morning. He points out that he had done all that was necessary in a practical respect; herein the fall had caused no confusion of ideas. "In short, it was a remarkable illustration of the fact that the brain lodges different mental powers; but one of those had been stupefied for some longer period of time by the overthrow."

Uses for Salicylic Acid.—The beneficial effects of salicylic acid as a medicine have been much discussed in the medical journals since 1875, when the acid was first administered as a remedy for rheumatism. Its antiseptic properties render it useful in eruptive diseases, in diphtheria; and it has the further advantage, when properly made, of being colourless and tasteless. It kills bacteria and other animalcules, and destroys the unpleasant odour of wounds. Professor Kolbe, of Leipsic, in his many experiments with the acid, found that rain or river water containing one-twenty-thousandth of a grain thereof would keep sweet in a warm room four weeks or more, while similar water not so treated soon became unpleasant to the taste. This was confirmed by an experiment on a large scale; water charged with one gramme of salicylic acid to twenty litres was placed on board ship for a year's voyage, and was found sweet and free from organic matter when at the end the casks were opened. Milk treated with the acid remains sweet more than a day longer than without it. Eggs, after a bath of the acidified water, keep sweet for months in a dry place; and meat sprinkled with the powdered acid and packed in a jar acquires no unpleasant odour. Wine may be kept from turning sour by the use of the acid; brewers find it useful in some of their processes; and its property of preventing putrefaction is turned to account in the making of glue and other manufactures.

The Effects of Starvation.—Dr. Cunningham, of the government sanitary staff in Calcutta, has made a careful investigation on "Certain Effects of Starvation on Vegetable and Animal Tissues." One effect in the human subject is the destruction of the intestinal mucous membrane. Hence the digestion and assimilation of nutritive materials supplied in the food must necessarily be impaired or destroyed, according to the degree of morbid change. Under such circumstances, the food elements not being submitted to their normal transformations, become mere foreign bodies liable to undergo decomposition, and well adapted to cause irritation. The conclusion to be drawn is one

that should be kept in mind by the functionaries appointed to administer relief in time of famine. The starvation must not be allowed to go on too long; for, as Dr. Cunningham observes, "the fatal diarrhœa and dysentery first manifested itself in people after their admission into the relief camps. The investigations show the absolute necessity of great caution in regard to dietetic experiments and dietetic systems of punishment. They show that it is not safe to push such procedures in the belief that, so long as no evident active evil results present themselves, we can at any time pull up and restore things to their normal state."

Variations of Blood in the Extremities.—It is a familiar experience that the amount of blood in the extremities undergoes considerable variations, and that the force of gravity especially affects it. A German observer, Herr Wolff, has recently studied this influence in a scientific way, and he used five different methods of measuring the degree of fulness of the blood, but got available values only with three—viz., determination of the temperature in the closed hollow of the hand, with different positions of the arm; and two different measurements of the water displaced by the arm when immersed, the position of the arm being varied. The effect in question on the temperature of the hand was surprising. Thus, in a boy of 8, the temperature fell (on raising of the arm) in 35 minutes from 34·8° to 31·2°, and again in an hour from 34·8° to 29·8°. In a man of 22 the raising of the arm brought the hand temperature from 29·5° to 28·6°. The arm being now let hang down, the temperature rose fully 7° in 20 minutes. From the experiments with displacement of water it appeared that with raised arm the head of an adult contained about 12cc. less blood than with the arm hanging; the hand, forearm, and lower third of the upper arm had about 30cc. less.

The Treatment of Diphtheria.—Professor Klebs, of Prague, describes in the *Med. Chir. Centralblatt* (No. 22) a series of experiments performed on himself and other persons to test the efficacy of benzoate of soda in destroying the formation of microscopic fungi in the body. He has found that it procured relief in several cases of gastric catarrh and other diseases which are often noticed in persons who work a great deal among decomposed organic substances. In order, however, to be quite certain of the antiseptic or antimycetic power of this drug, it was necessary to find out whether, when introduced into the body of a healthy animal, it would enable it to resist infection. Diphtheretic membranes were accordingly soaked for some time in Buchholtz's solution, then mixed with benzoate of soda, and inoculated upon the surface of several healthy animals, of which some had previously received a hypodermic injection of the above-mentioned substance. It was then shown that in those animals which had had the injection the diphtheretic membrane was destroyed in ten minutes, whilst it still could be seen in the eyes of the others two hours after the operation. Klebs

has administered benzoate of soda in doses varying from five grammes to his patients, who never experienced the least inconvenience from it.

Simple Diet.—Dr. C. M. Easton, writing in the *St. Louis Medical Journal* for February, says that a man, when twenty-five years of age, swallowed by mistake a corrosive acid, which produced great soreness of the mouth and throat, and resulted in œsophageal stricture. Being unable to swallow solid food, and being also fond of milk and cake, he made that his exclusive diet. On this diet, he said, he had lived for about fifty-five years; and his story was corroborated by his wife and daughter. His wife said that she made his cake very sweet and short; he dissolved it in his milk. He could not and did not swallow anything as large as an apple-seed after his injury. He was a farmer, and up to within a few years of his death was able to perform laborious farm work. This man lived to something over fourscore years. The extreme contraction of the œsophagus, the exclusiveness of the diet, his ability to perform hard labour, with his long lease of life, are noteworthy facts.

A Curious Disease.—A French physician, Dr. Legrand du Saule, has lately been investigating a curious form of disease, which has been called *agoraphobia*, and which consists in a fear of open space. The persons affected by it have this fear in various circumstances, on the street, in a theatre or church, on a slightly elevated floor, at a window opening on a large court or open country, in an omnibus, on a ship or a bridge, &c. The fear is accompanied by sudden weakness of limbs, tingling sensations, and numbness. The person does not know what he fears; yet his intellect is generally sound, as also his free will. Without assistance he will sometimes hesitate a quarter of an hour before venturing to cross a quiet street. The fear is more apt to come on the longer the person has been fasting, and less so immediately after a good dinner. The causes of the disease are obscure. M. Legrand du Saule thinks it is sometimes brought on by immoderate drinking of black coffee. The primary agoraphobia (an idiopathic state) is most often observed in men intelligent and lettered, who are in the prime of life. Women, on the other hand, are more frequently affected by the secondary form, where it is combined with a number of other nervous disorders. The author shows that the phenomena are quite distinct from those of vertigo or giddiness.

As regards cure, bromide of potassium and hydropathic treatment have been found useful. Moral suasion has a great power. "Let the physician will, and impose his will; let him prove, with conviction, the inanity of the danger; let him reassure the patient, and the latter will cease from his anxieties, and at length conclude a long armistice with his nervous disorder."

Mental Disease in Prussia.—A remarkable lecture on this subject was lately delivered by Herr Finkelburg, Professor of Medicine and Member of the Commission of Public Health. In Prussia,

one person in 450 is affected with insanity, a high figure, calling for investigation of the causes of such disorder. Among the working classes, it was pointed out, the lack of physical and intellectual education, insufficient food, unhealthy dwellings, and a certain indolence of mind, contribute partly to the evil. But it is chiefly the abuse of alcoholic liquors that fills the lunatic asylums as well as the prisons. In the former, drunkards figure to the extent of a fifth; in the prisons, two-fifths of the total. If the brandy bottle could be kept in its right place, the druggist's shop, the social problem in question would (according to the Professor) be nearly solved. With regard to educated people, the causes of their insanity are naturally very different, and they often date from the earliest education.

Children do not, in general, get so much rest as they absolutely need. That a child work diligently, keep its place in the class, or quickly advance to a higher class, is all that is demanded, and people do not trouble themselves in the least as to whether the young and tender brain, kept in incessant activity, may not stop suddenly in its functions or its growth. Rousseau insisted on a purely negative education till 12 years of age, and in this he was wiser than our pedagogues. The child who has lived in the open air to this age without contracting bad habits will have greater force of apprehension, and will progress more rapidly than another who has been fatigued by premature work. Among adults the Professor distinguishes two great classes—men of work, and men of pleasure. He showed without difficulty that continual activity and the suitable exercise of all the faculties are necessary to the preservation of intellectual and physical health, for it is the idlers that furnish the greatest number of hypochondriacs. But there is the excess of the overworked man, who is liable to mental maladies arising from fatigue of mind, joined with material cares, absence of sleep, emotions and agitations caused by a goal always imagined but never reached. Professor Finkelburg concluded that every man should try as much as possible to vary his occupations, whatever they be, to distract himself from too absorbing thoughts, to give his tired mind agreeable recreation, to take walks regularly in the open air, &c., in order to restore the equilibrium of functions of body and mind.

Salicylic Acid in Beer.—M. Blas, corresponding member of the Belgian Academy of Medicine, has, in *La Presse Médicale*, called attention to this subject. Four years ago, he says, Professor Kolbe, of Leipsic, was the first to notice the anti-putrescent and anti-fermenting properties of this acid, and at the same time indicated the possible application of this new agent. It is now generally acknowledged that when this acid is added to beer in the proportion of from one to two decigrammes to the litre, or ten to twenty grammes to the hectolitre, the beer is preserved from secondary and injurious fermentation. Without either the taste or the appearance, or the slow alcoholic fermentation of beer being at all

modified, the action of secondary ferment is paralysed, and it is only in larger quantities than that above mentioned that the acid has any destructive effect upon the ordinary constituents of beer. It occurred, therefore, to M. Blas to inquire whether this acid was used by brewers for the purpose of adulterating their beers, and the result of his investigations showed that this acid was used by them on a large scale, approximating in the proportion of five to ten grammes per hectolitre. He found, however, by several experiments, detailed in his paper, that this quantity of salicylic acid in beer did not exercise any injurious influence upon the health. Other observers are of the same opinion, but further experience is acknowledged to be necessary before beer thus adulterated can be said to be absolutely harmless.

Rabies in Dogs.—A contribution to knowledge of this disorder has been recently made by M. Galtier (*Comptes-Rendus*). The most important of the conclusions which he draws from his experiments is that the saliva of a mad dog, obtained from the living animal and kept in water, continues virulent five, fourteen, and even twenty-four hours afterwards. This fact has consequences which everybody should be aware of. Thus it seems that the water of a vessel in which a mad dog may have dropped some of its saliva in attempting to drink should be considered virulent at least during twenty-four hours; and next, that as the saliva of a mad dog which has succumbed to the malady or has been killed does not lose its properties through mere cooling of the body, it is important, in examining the cavities of the mouth and throat after death, to guard against the possible danger of inoculation. M. Galtier tested rabbits with regard to rabies, and found it transmissible to them from the dog; also, the rabbits' rabies from them to animals of the same species. The chief symptoms are paralysis and convulsions. The animal may live from a few hours to four days after the disease has declared itself. It is notable that the period of incubation is much shorter in the rabbit than in other animals, and this makes the rabbit a useful reagent for determining the virulence of a particular liquid. M. Galtier found salicylic acid, injected daily under the skin, powerless to prevent the development of the disorder in rabbits.

What is Thrush?—Dr. Hassloch, of New York, in the course of researches "On the Structure and Growth of some Forms of Mildew," found that "the greyish-white patches occurring in the mouths of infants, known as *thrush*, contain, besides epithelia, very delicate granules in active dancing motion — micrococci; short, single or double oscillating rods—bacteria; delicate threads, straight or variously curved, sometimes resembling chains—leptothrix; and, finally, oidia. After being kept forty-eight hours in a moist chamber, the mass removed from the mouth shows a number of delicate mycelia, the hyphæ of which have small sporangia. This vegetation," as Dr. Hassloch states, "is identical with that of mildew.

The oidia correspond in size to those of wine; many contain large vacuoles, in all details like those obtained from beer and wine, differing only and slightly in the colour of the shell."

The Contagion of Yellow Fever.—Dr. Schmidt, of New Orleans, after much study and observation, has come to the conclusion that the contagion of yellow fever is a poison "of animal origin, or, in other words, is a product of a secreting cell, mainly eliminated by the glands of the skin in a liquid form, to be rapidly converted into a vapour." The disagreeable odour of yellow fever arises from the poison being a product of a modified or vitiated secretion. The poison having been in active existence ever since it was first known to the civilized world, has travelled from country to country, and may be kept at bay by a strict and properly regulated quarantine. For this a sure knowledge is required of some chemical agent which will destroy the poison without destroying the articles or merchandise which it may be needful to disinfect. The American Public Health Association, in a report recently published, state they have not found a single instance of yellow fever originating in any locality; it has always been imported. When the disease appears in places wide apart, the transmission appears to be wholly due to human intercourse; and the Association are convinced that the only trustworthy means of prevention is isolation. "Quarantines," they state, "established with such a degree of surveillance and rigour that absolute non-intercourse is the result, have effectually, and without exception, protected those quarantined from yellow fever." In this there appears to be a suggestion for the functionaries who are engaged in investigating the plague.

Transplanting Teeth. — Can teeth be transplanted? If recent accounts of operations by dentists are trustworthy, the answer must be in the affirmative. But the question has been formally discussed at a meeting of the Odontological Society, and from this we learn that it was in *replanting* (which is not the same thing as *transplanting*) that the foreign dentists whose names had been cited achieved their success. Among them, a Frenchman, Dr. Magitot, has published full particulars of cases in which diseased teeth were taken out, and the root, or a portion of periosteum, was cut away, and then were replanted in the same socket, where, after a few days or weeks, they became firm and serviceable. Out of sixty-three operations in four years, five were failures; but some of the cures were painful and tedious, owing to local discharge. In technical phraseology, Dr. Magitot holds "the indications for an operation to be the existence of chronic periostitis of the apex of the root, its denudation, and absorption of its surface. . . . The resection of this, which plays the part of irritant, is the essential aim of the operation. And the extraction having been performed with due care, if no other lesion be detected save the alteration in the apex of the root, the tooth is to be replaced as soon as this

has been excised and smoothed, and the hæmorrhage has ceased."

From this it will be understood that the pulling of teeth from one human jaw in order to plant them in another is very far from being an accomplished fact. And it is fair to mention that some English dentists practised the replanting of teeth ten years ago; and there is an instance on record of a re-planting successfully performed in 1853. For further information, the *Transactions of the Odontological Society*, the *Review of Dental Surgery*, and the *Bulletins et Mémoires de la Société de Chirurgie* may be referred to.

The Physiology of Recreation.—During the course of the year covered by the current volume of the "Year-Book of Facts," Mr. George Romanes, M.A., delivered a drawing-room lecture at the residence of Mr. Charles Mathews, thus winding up a series recently delivered by various scientific authorities, under the auspices of the National Health Society. The object of that society, which is now in its sixth year, is to spread a knowledge of the laws of health in every possible way among all classes. Many hundreds of simple and practical lectures on air, ventilation, food and cookery, the prevention of the spread of disease, and kindred subjects, have been delivered at working men's clubs, mothers' meetings, and elsewhere, in some of the poorest and most crowded parts of London, with the most encouraging results; while, as in the present instance, the higher ranks have also been addressed. Papers and leaflets have likewise been issued, orders for which have come from Russia, Cape Town, New Zealand, America, Paris, and Berlin. For the University of the last capital, in particular, and for the Princess of Prussia, who is much interested in sanitary matters, copies of all the publications on the society's long list were secured last year by Dr. Oscar Liebreich. Play-grounds, park excursions, and prizes for cookery, swimming, physiology, &c., come also within its province.

Mr. Romanes, with a view to giving his audience a clear notion of what recreation means, reminded them that, as to create signifies to form, re-creation denotes forming anew. In that word, therefore, our forefathers embodied their idea that recreation ought not to be a pastime, indulged in for the pleasure it brought with it, but an act of duty in itself, performed with a view to regaining strength for further duty. In their spirit he would define recreation as that which, with the least expenditure of time, renders the exhausted energies best fitted to resume their work. Coming, then, to the physiology of recreation, to the description of which neither fun nor even more profitable diversion answered in the absence of the recuperative element, they had to find out why some actions or pursuits were recreative and others not. Evidently, it did not depend on the mere relief from toil, since the sportsman's week on the moors involved more hard work than the collier's in the mines. Rowing, which was play to the student, was a serious business to the bargeman, and no gardener was like his master in digging for

digging's sake. The only principle which would explain the recreative quality in all cases was the physiological necessity for frequent changes of functional activity.

In order to make this clear, the lecturer briefly explained the physiology of nutrition. He showed that in the various bodily tissues there is always a twofold process going on—(1) that of receiving nourishment from the blood, whereby they are being constantly built up into an efficient state for the performance of their various functions ; (2) that of discharging into the blood the used-up materials. Now, an organ at work is undergoing wear and tear, which it is the business of nutrition to make good. If the work done be in excess of the nutriment furnished, the organ or tissue must stop work through exhaustion — must sleep, in short, until nutrition shall have done the repairs. Sleep is nothing else than the time of general rest, during which the process of nutrition is allowed to gain upon that of exhaustion. But besides general exhaustion and rest in sleep, there is local rest, following on local exhaustion, as when the muscles of the arm are no longer able to hold out a heavy weight, until the overtasked limb has rested awhile.

The physiology of nutrition, Mr. Romanes repeated, would clear up his meaning as to the dependence of the recreative principle on the physiological necessity for a frequent change of functional activity. For although in the case of some organs, such as those of secretion, functional activity is pretty constant, owing to the constant expenditure of energy being just about balanced by the constant income, this is not so in the case of nerves and muscles. All the time nerves and muscles are at work their expenditure of energy is so vastly greater than their income that they can only carry on by drawing on the stores laid up by them during the comparatively long periods of their previous rest. But this is true of nerve and muscle only, and what it amounts to is simply this—a change of functional activity, having for its object the affording of time for the nutrition of exhausted portions of the body. A part of the body having become exhausted by work done, and yet the whole of the body not being so far exhausted as to need sleep, recreation comes in to afford the worn-out part local sleep, by transferring the scene of activity thence to some other part. It is thus clear that in a physiological sense, no less than in a psychological sense, the term recreation is a singularly happy one.

It will be seen that, as a matter of fact, the whole physiology of recreation consists merely in a re-building up, re-forming, or re-creation of organs and tissues that have become partly disintegrated by the exhausting effects of work. Thus, in this physiological sense, recreation is partial sleep, while sleep is universal re-creation. It would now be seen why it is that the one essential principle of all recreation must be variety, which merely means the substitution of one set of activities for another, and consequently the successive affording

of rest to bodily structures as they become successively exhausted. The undergraduate finds recreation in rowing, because it gives his brain time to recover its exhausted energies; while the historian and the man of science find mutual recreation in each other's labours, because these labours require somewhat different faculties of mind for their pursuance.

The Secrets of Nature.—The Harveian Oration was delivered on the 5th of June, 1879, at the Royal College of Physicians, by Dr. Wilks, F.R.S., who took for his theme the injunction of Harvey to his followers, "to study and search out the secrets of nature by way of experiment." He showed that the opportunity was only given to the few to devote themselves to physiological discovery; but that all medical men had it in their power to aid in this department of knowledge by studying the secrets of nature through the means of experiments made for them in case of accidents and disease to which their fellow creatures were liable. In this way a considerable amount of knowledge of the functions and uses of the organs had been obtained; and as regards the brain, its various forms of disease had done much to elucidate mental processes, and more especially the nature of language. A physician should therefore be not only practising his art, but should also be cultivating sciences; and Dr. Wilks showed that this was the side of the medical man's office quite ignored by the public, or even regarded with jealousy should he in his capacity as physician to a hospital be suspected of devoting any part of his energies, or of the subscription money, to the elucidation of any physiological or pathological facts rather than to the treatment of his patients.

He then dwelt upon the opportunities which the medical man had of studying his fellow-creatures under every aspect, and inferred that mental philosophy or psychology would enter into his domain, since he had to deal with the functions of animal life. Pure metaphysics might still be confined to its own proper sphere. He insisted on the right to make this a branch of physiological inquiry, and defended the scientific method of research by which it was intended that man should be taken and studied in all his anatomical and physiological bearings, together with all his attributes, in the same way as animals are studied by the naturalist and the inorganic world by the physicist or chemist. In the study of the latter we excluded from our laboratory all metaphysical inquiry about substratum and phenomena, leaving this for pure metaphysics, but took the common-sense of mankind, which was understood by all; and so, in the same way and by similar means, we endeavoured to investigate man and animals both in their organization and functions; and it was maintained that the only clue to a correct knowledge of man, both in his corporal and mental attributes, must be by this scientific method. The system had been stoutly attacked until the word "material" had become a term of opprobrium.

Dr. Wilks then alluded to the

long-debated subject of the discovery of the circulation being made before the "Novum Organum" was published, and that it was accomplished by a method opposed to the Baconian teaching. He explained that there was but one method of inquiry which every investigator instinctively felt to be the right one, although ignorant of the philosophic systems. The genius of the scientific man consisted of a power of seeing, of experimenting, and of theorizing, which was exemplified in the work done by Newton, Harvey, Jenner, Faraday, and all other discoverers. The circumstance of Harvey so soon succeeding Bacon was only an illustration of the fact that the Elizabethan period was the birth-time of great men, and it was then that the Colleges of Physicians and Surgeons were founded.

He afterwards showed how discoveries were made by the observation of a simple fact, and by an attempt to solve its meaning; how the solution of another problem was added to this until a wide theory was at last framed, and therefore knowledge was of slow growth. The contemplation of any great fact in nature never led the observer to the interpretation of its meaning; the sight of the rainbow in the clouds or the sound of the thunder gave no clue to their causes; but the examination of the light passing through the keyhole, or the watching the effects of the friction of a piece of wax, revealed the primary laws which afforded the explanation. It were useless to attempt to interpret complex phenomena. The scientific method is one of progression step by step until the top of the ladder is reached, and thus human knowledge is of slow growth, like all the faculties of the mind, and even of the material world around us. The world was progressing, and therefore the greatest discovery ever made by man about himself, and the world of which he forms a part, was the doctrine of evolution. Coleridge long ago had discovered this by his own method of thought. The doctrine first traced in smaller material things was now found to be true of the world at large, and was now being made applicable to the great subjects of morals and religion. An argument, therefore, for its truth was found within itself.

Dr. Wilks then defended the study of science as in any sense antagonistic to other intellectual pursuits. He could see how those engaged in art or pure literature would feel repugnance at the sight of objects in nature stripped of their form or colour by the chemist or anatomist, but those who had familiarized themselves with these details by no means lost their sense of the beautiful, for several members of the medical profession would not have disgraced any department of art. But such an example as Goethe was sufficient to prove that the scientific and most imaginative minds might coexist, for the author of "Faust" and "Wilhelm Meister" could find food for his intellect in the study of a flower, of the rays of light, or of the intermaxillary bone. It wanted but a moment's consideration to see that if the world were, as this great man said, the living gar-

ment of God, all aspects of nature were true, and must be combined in the mind of the Author of all things.

The lecturer concluded by urging once more upon members of the college that, while they might be occupied in discussion upon the various systems of the treatment of disease, one duty inculcated by Harvey was ever before them—that of studying and searching out the secrets of nature.

Retinal Activity. — Professor Sylvanus P. Thompson, at the meeting of the British Association, offered some explanations on a law of retinal activity. He referred to some new optical illusions, previously treated on by himself, which are those of the subjective motion observed in apparent existence after the eye has for some time been fixed upon a moving object, and which are executed apparently in an opposite direction. The speaker's explanation was that the retina ceases to perceive as a motion a steady motion of images that pass for some time over a particular region; and to a portion of the retina so effected, a body that is not in motion appears to be moving in a complementary sense.

Colour Blindness amongst Negroes.—Dr. Swan M. Burnett, of Washington, has recently made some examinations for the purpose of ascertaining whether the negro in the United States is affected with colour-blindness to the same degree as the white race. He has examined 3,050 coloured children, from 6 to 18 years of age, in the public schools of the districts of Columbia, of whom 1,359 were males and 1,691 females. Of these 22 boys were colour-blind (or 1·6 per cent.), and two girls (or 0·11 per cent). The percentage of colour-blindness among the whites in an aggregate of about 40,000 examinations is 3 per cent. for males, and 0·26 for females. The negro appears, therefore, to be less liable to this defect than the white race. The examinations were made in strict accordance with the plan proposed by Professor Holmgren, of Upsala, Sweden, and used so extensively in making similar examinations in Europe.

An Unhealthy Atmosphere.—It is known that methylic alcohol, or wood spirit, is extensively used in adulteration of spirits of wine destined for commerce. Some recent observations by a medical professor in Nancy, M. Poincarré, seem to show that its use is apt to give trouble. He made some animals live several months in an atmosphere, renewed, indeed, but constantly charged with vapours of methylic alcohol, and found that they became subject to various disorders. One notices first a tendency to embonpoint owing to abnormal development of the abdomen. This is chiefly due to enlargement of the liver, which shows fatty degeneration, as do also the heart and the lungs. The brain is congested, and the meninges are inflamed, &c. As many workmen—*e.g.*, hatters, live in an atmosphere charged constantly with vapours of wood spirit, the facts just given should be taken into serious consideration by hygienists.

X.—THE WORLD OF INDUSTRY.

Boiled Tires.—Water is said to be much better than fire for the heating of tires preparatory to shrinking them on a wheel. In a fire the heating is irregular, and consequently the shrinking; but if a tire be boiled in water ten minutes, it will be of uniform temperature and will contract uniformly upon the wheel. Besides, the boiled tires are not so liable to crack or become loose as those heated in the fire.

A New Method of Blasting Coal.—At a meeting of the Manchester Geological Society, Mr. W. E. Garforth gave an account of a method of blasting coal in mines by means of compressed air, whereby the risk attending the use of gunpowder is obviated. With a portable machine of simple construction, which can be worked by two men, he gets a pressure of more than 14,000 pounds to the square inch. The cartridge, an iron tube, is drilled into the coal; the pipe from the compressor is connected, the air is forced in, and, in the experiments hitherto made, the cartridge bursts, and the coal falls before a pressure of 10,000 pounds to the inch is reached. When coal is brought down by firing a charge of gunpowder, half an hour or more is wasted while the smoke drifts away from the working, before the miners can resume their labour; whereas the sudden expansion of the compressed air may be regarded as beneficial. To obviate the objection that the labour of working the compressor in the heated air of a mine would be exhausting, Mr. Garforth proposes to fill receivers with compressed air above ground, or at the foot of the shaft then transport them to the several workings, and there burst the cartridges by liberating the imprisoned air. It is said that this method is more expensive than blasting by gunpowder; but there is much in its favour; and considering the appalling loss of life of late years in coal-mines, the Government Commission appointed last session to inquire into the subject will in all probability recommend that the use of gunpowder should be forbidden.

Remarkable Photographs.—At a recent session of the Berlin Association for the Promotion of Photography, among other specimens of photography exhibited, were some remarkable landscape pictures by Herr Holtermann, of Sydney, Australia. These are more especially distinguished for their size; they are mounted on an endless band of paper, strengthened with linen, nearly 100 feet long. Two colossal panoramas of Sydney and Melbourne have been each made from about a dozen sheets, 18 by 20 inches, very skilfully joined together; the separate parts harmonise very completely in drawing, tone, and depth. The last on the list was a

picture which, as could easily be seen, had been printed from a single negative, and its size, 150 by 93 centimetres, showed it to be quite an uncommon photographic feat.

A New Instrument for the Mineral Analyst.—At a recent meeting of the Philadelphia Academy of Natural Sciences, Professor Koenig, of the University of Pennsylvania, exhibited what he calls a chromometer (or colour-measurer), a new instrument he has designed for making exquisitely delicate determinations of the presence of certain metals in ores. It is based on the optical fact that complementary colours will extinguish each other if mixed in proper proportions; *e.g.*, if to a green solution a red solution be added in suitable proportions, the liquid will become colourless. Professor Koenig has applied this principle to the colours which certain metals, as iron, manganese, copper, &c., produce when fused with borax, the only chemical used in this method of analysis. He prepares such glasses or beads containing known quantities of a metal in one hundred parts, and observes how thick a glass of the complementary colour must be to produce extinction. This chromometer is furnished with a glass wedge of a green or red colour cut at an angle of about one degree. By moving this wedge before the glass bead, with the help of a suitable rack movement, a scale is moved at the same time, and when the point of extinction of colour is arrived at, the reading of the scale refers to a table showing the percentage of metal contained in the examined substance. By this method of analysis a correct determination of manganese in iron ore can be made in 15 minutes, which is not more than one-third of the time required by the usual methods of analysis.

An Improvement in Puddling Furnaces.—At one of the ironworks in France a contrivance has been introduced for combining hot air and superheated steam in puddling furnaces. The grates, the sides of the fire-boxes, of the ashpit, and all the hottest portions of the apparatus are connected with air-chambers, which are supplied with vapour in such a manner as to increase their durability, and at the same time afford an ample quantity of air for the draught, heated to a temperature of from four hundred and fifty to five hundred degrees. By means of this elevated temperature it has become possible to apply superheated steam under the grate, and effect an important saving by its decomposition.

Soap-stone as a Lubricant.—A writer in one of the foreign technical journals expresses a decided preference for soap-stone powder, in the form of dust, as a lubricant for the axles of machines. For this purpose it is first reduced to a very fine powder, then washed to remove all gritty particles, then steeped for a short time in dilute muriatic acid, in which it is stirred until all particles of iron which it contains are dissolved. The powder is then washed in pure water again to remove all traces of acid, after which it is dried, and is the purified steatite powder used for lubrication. It is not used alone, but is mixed with oils and fats, in

the proportion of about 35 per cent. of the powder added to paraffin, rape, or other oil; or the powder may be mixed with any of the soapy compounds employed in the lubrication of heavy machinery.

The Manufacture of Crucible Steel.—In the course of a paper read before the British Association, Mr. Bell said that the manufacture of crucible steel is one of the most important industries connected with Sheffield, which boasts of not less than 120 firms engaged in the production of this material. Notwithstanding the enormous output of steel by the Bessemer and Siemens-Martin processes, this kind of steel is unrivalled for the manufacture of the finer varieties of cutlery and edged tools, &c. A brief outline of the process itself is as follows:—The most of the iron employed for this purpose is imported into this country, in the shape of bars, from Sweden, where it has been smelted from very pure iron ore, in a blast furnace, by the aid of charcoal, and subsequently puddled to free it from impurities. The first operation to which it is subjected is that known as the cementation or converting process, the object of which is to combine a certain quantity of carbon with the iron; this operation is performed in a furnace of peculiar construction, where the iron and charcoal are packed together in air-tight chests or converting pots, subjected to a high temperature short of the fusing point of iron, where it remains for a matter of three weeks. After the conversion, when the pots are cold, the bars are taken out and found to be covered with blisters, hence it is termed blister steel. The steel is now broken up into small pieces and melted in crucibles, and cast into ingots. These are sent to the forge, where they are heated and rolled. In this part of the process the chief difficulty with which the silter has to contend is the porous or "honeycombed" structure of the steel. One of the characteristic features relied on by practical men as indicating the quality of a piece of steel is the appearance of its fracture; but this is by no means an infallible test, as the fineness or coarseness of grain can be produced by mechanical treatment or chemical means.

Plumbago as a Lubricant.—The value of dry plumbago as a substitute for oils and tallow for steam cylinders is emphatically indorsed by a mechanical expert in the *American Machinist*. The engine had a piston speed 300 feet per minute, and is known as the "West Poppet-Valve Automatic Engine." It was worked up to its full capacity. A third of an ounce of finely-powdered Ceylon plumbago, moistened with a little water, is placed in the cup twice a day, and after eighteen months' constant use, has been found to answer perfectly.

A Remarkable Testing Machine.—The 400-ton testing machine, which was ordered, in 1875, by the United States Board appointed to test "iron, steel, and other metals," has recently been finished, tested, and accepted. It is the invention of Mr. A. H. Emery, and was built at the Ames Works, Chickopee, Massachusetts. Among the tests were these:—A

forged link of hard wrought-iron, 5 in. in diameter between the eyes, was slowly strained in tension, and broke short off with a loud report at 722,800lb. To see if the weighing parts had been disturbed by the great recoil, a horse-hair was next tested. It was 7-1,000 of an inch in diameter; it stretched 30 per cent., and broke at 1lb. Other horse-hairs varied between 1lb. and 2lb. The accuracy of these small tests, and others, up to some hundreds of pounds, was checked and proved by other weighing machines. Specimens were submitted to a million pounds compression; and after these, delicate structures, such as eggs and nuts, were tested in compression, and violin strings in tension. The machine consists of a double-acting straining cylinder and ram on a carriage, at one end, and a movable weighing apparatus at the other, the two being connected by a pair of screws 48 ft. long. The weighing apparatus is a reversed hydrostatic press, having diaphragms instead of pistons. The load is transferred by means of a fluid (alcohol and glycerine), and successive series of large and small diaphragms, to a system of scale beams.

A Good Coating for Steam-pipes.—At Boulogne it has been found that a dough made of saw-dust and flour is a good coating for preventing the escape of heat from steam-pipes, cylinders, and other exposed surfaces connected with steam-machinery. Its cost is moderate, and it may be applied with a trowel.

The Advantages of Steel Hawsers.—Comparative trials have been made of flexible steel and wire hawsers against hemp hawsers and iron chains. The breaking strain of a steel hawser eight inches in circumference is about one hundred and fifty tons, and the weight of one hundred and fifty fathoms is sixty-seven hundredweight. The largest chain used in the naval service weighs four hundred and fifty hundred-weight to one hundred and fifty fathoms, comprising nine hundred links, and as each link has a weld, there is liability to nine hundred imperfections, whereas the steel-wire hawser is throughout of uniform strength. The weight of a tarred hemp hawser is also much in excess of the steel hawser; hence the superiority of the latter for raising heavy weights from the bottom of the sea, or for ordinary naval purposes, is manifest. One of these steel hawsers tested at Devonport was sufficiently flexible to allow of a turn being taken therewith round a post one foot in diameter.

A Heating Blast for Furnaces.—Mr. E. A. Cowper, C.E., read a paper before the British Association on recent practice in heating air for blast furnaces. The paper described the improvements introduced in recent years for heating the air for blowing blast furnaces by a more perfect application of the regenerative system, by which the waste gases from the top of the blast furnace, when in a state of perfect combustion in the hot-blast stove (during the time of heating it), were distributed in a more perfect manner than heretofore; so that the hot products of combustion were caused to heat the whole area of the regenerator in an equal

manner: the result being a large increase in the power of the stoves, as well as a saving of time in heating. By the improved combustion of the gases a higher degree of temperature was produced in practice, and a higher temperature of blast was realised, whilst the products of combustion finally left the stove at a lower temperature, so that economy in gas followed as a consequence. Upwards of 110 stoves were now in use and at work in England, France, Switzerland and America, giving perfect satisfaction, and realising an economy in fuel of 20 to 30 per cent., while 20 per cent. more iron was made from the same plant, of furnace, blowing engine, and boiler.

The Manufacture of White-Lead.—A new method of manufacturing white-lead deserves a word of notice. Very fine ground litharge is subjected, in a mixing vessel, to the action of salt brine; and chloride of lead and caustic soda are produced. This mass is then run into an iron vessel, into which carbonic acid is pumped, causing a further chemical change in the production of carbonate of lead and common salt once more; and the latter, being washed out from the white-lead, may be used over again as in the first operation. The patent white-lead produced in this way appears to be very white and chemically pure, but is not quite so heavy as the white-lead made by the old process.

Friction at High Velocities.—Captain Douglas Galton, C.B., F.R.S., read a paper before the British Association, on "Some Further Results of Experiments on Friction at High Velocities." The results of the gallant captain's experiments led him to come to the conclusion that the brake should be applied to every wheel of a train simultaneously, and that the utmost power of the brake should at once be used. A perfect brake should supply the instantaneous application of the greatest amount of retarding force. A train of 15 vehicles, weighing 200 tons, at an energy of 60 miles per hour is equal to 34,000 tons falling a distance of 1 ft. As at a speed of 60 miles an hour a train passes over 88 ft. per second, to stop it quickly it was required—first, that the brake blocks should be applied to and act upon every wheel in the train; secondly, that they should be applied with their full force in the least possible time; thirdly, that the pressure should be regulated according to speed and other circumstances, so that the friction should nearly equal but never exceed the adhesion of the wheels upon the rails. The paper concluded with the results of a number of experiments.

The Separation of Silver from Lead.—The separation of silver from lead has been effected by hand-labour; but this is now superseded by applying steam "as an agitator in the pot where the crystallisation of the pure lead takes place, and in other respects it produces a chemical change, and facilitates the work." Another process separates the silver "by means of zinc, which is found to wash the melted lead entirely free of the silver contained in it, and the mixture of silver and zinc floats to the top of the pot and is skimmed off. When this is com-

pleted, the mixture of zinc and silver is placed in plumbago crucibles, in a furnace, and the zinc is distilled off and collected in small metal chambers, where it cools in the form of cake-zinc, and is fit for use again." By this means about half of the original zinc is saved, and it is thought that the other half may be recoverable.

A Mistake about Steel.—A popular notion prevails that the hardest steel is the most durable; but it appears from accounts of experiments communicated to a meeting of civil engineers, that the contrary is the fact. Remarkable differences in the wear of steel rails laid side by side had been observed on the Great Northern Railway; seven of the rails were taken up and tested, and it was found in one instance that a hard rail had been worn away one-sixteenth of an inch by traffic amounting to 5,251,000 tons; while a soft rail for the same amount of wear had withstood 8,402,000 tons. In another instance the total was 15,531,000 tons for the hard rail, and 31,061,000 tons for the soft rail, the wear being the same—namely one-sixteenth of an inch. On analysing this last-mentioned rail it was found to consist of 99·475 per cent of iron, and very minute quantities of carbon, phosphorus, silicon, manganese, sulphur, and copper.

Dr. Dudley, chemist to the Pennsylvania Railway Company, commenting on these and other parallel facts, remarks: "The indications would seem to be that under the conditions of wear to which a steel rail is subjected—namely, rolling friction, unlubricated surfaces, and great weight with small bearing surface—the quality of the metal necessary to most successfully withstand the disintegrating forces is best expressed by the word toughness, and not by hardness."

New Unicycle.—A single wheel, wherein is arranged a seat for the traveller who is to propel it, has been invented by Mr. J. Heronemus, of Emdrup, near Copenhagen. The wheel has one central rim, and to this are fixed the arms, which are (say) six or eight in number, half of them swelled, extended, or bellied out to one side, and half of them similarly to the other side, each set of arms being fixed to a nave or boss; these arms are bent out so far, and the naves are so far apart, that the traveller, when in the sitting posture, finds room in the wheel between them. The arms are by preference not arranged opposite to one another on the two sides, but intermediately. The naves carry each a crank, and these cranks are, by connecting rods, jointed to two bell-crank levers, having one arm placed about upright in a position convenient to the traveller to take hold of for working them backwards and forwards alternately. Each bell-crank lever has its fulcrum in the seat for the traveller, which seat is hung from the naves or axles of the wheel. The seat is by preference made in scroll form, of light, open-work steel plate or wire-work, or partly so, and may have a part extending overhead to carry an awning to protect against dirt thrown up, and against rain. From each nave there may be hung a leg serving to steady the

velocipede while entering the same, but which can be thrown up out of the way when travelling. The wheel, arms, and the rim may be fitted with stiffeners or diagonals to distribute the weight or strain over the rim as much as possible. The velocipede may be eight feet and upwards in diameter, and by this, and by the facility for working it, a very great speed is attained, and with safety to the traveller.

Steel Rails v. Iron Rails.—It has been ascertained by experience that a rail of Bessemer steel will last nine times as long as an iron rail. About one-third of the railway mileage in this country is laid with Bessemer steel rails, and the economy thereby effected is well pointed out by Mr. Price Williams, who states: "It is estimated that the annual saving in labour alone, in the ordinary maintenance of the lines, which has resulted from the less frequent breaking up of the permanent way where steel rails are now used, is equivalent to the saving of the services of at least a man in every three miles; and this at £17 per mile will, on 10,194 miles of single line already laid with steel rails, these being the most heavily worked sections, represent an annual saving of £173,298;" to which must be added the much larger sum saved by not having to renew the rails so frequently as in former years.

An Advance in Photography.—It would be a triumph of optics and chemistry if photographs could be made to represent the natural colours of objects. Attempts towards this result have hitherto ended for the most part in disappointment. But Captain Abney, in a short paper "On the Production of Coloured Spectra by Light," read before the Royal Society, makes known that he has succeeded in producing, approximately in the natural colours, pictures of the solar spectrum on silver plates, and also, but less brilliantly, on compounds of silver held in place by collodion. "I reserve for the present," he writes, "the exact details of the production of these pictures, but may say that they are produced by oxidation of silver compounds when placed in the spectrum; an exposure of two minutes being amply sufficient with a wide slit to impress the colours. The colouring-matter seems to be due to a mixture of two different sizes of molecules of the same chemical composition, one of which absorbs at the blue end, and the other at the red end of the spectrum, and the sizes of these molecules are unalterable while exposed to the same wave-lengths as those by which they were produced." And he is of opinion "that the colours may be preserved unchanged when exposed to ordinary daylight." From this it will be understood that Captain Abney has made a step in advance, of high importance.

Lighting Buoys with Gas.—Experiments have been made by the Trinity House on the lighting of buoys with gas, which is manufactured from waste fatty matters or the refuse of oil-works. This gas is passed into the buoys under severe pressure, until a sufficient charge is accumulated to burn for three or four weeks,

showing a bright light by night and day, even in boisterous weather. Here, then, is a means of lighting an intricate channel, or a passage, or of indicating the position of a wreck, which cannot fail to be useful; and the Trinity Board have ordered the construction of two buoys which will hold compressed gas enough to burn from four to six months. With these, further and, as we may assume, conclusive experiments will be carried on in the estuary of the Thames. The same kind of gas is, we are informed, also used for the lighting of railway trains.

In the Forests of Victoria.—It is satisfactory to learn from the anniversary address of Mr. Ellery, President of the Royal Society of Victoria, Australia, that legislative measures have been taken to check the "reckless" destruction of timber in the forests of that colony, where rival owners of saw-mills have chopped down trees out of spite, and then left them to rot. The Department of Agricultnre, supported by the new laws, has begun to reafforest the stripped mountain-sides with exotic as well as indigenous trees, whereby the state nurseries at Mount Macedon are making "wonderful progress," and a valuable growth now covers a large part of the summit. From these nurseries thousands of plants are distributed to other parts of the colony; and it is remarkable that many of the European and American timber trees thrive better than the native, and grow more rapidly than in their original habitat. "It is intended also," says Mr. Ellery, "to sow many of our wrecked forest areas broadcast with the seeds of indigenous trees, notably the ironbark, and the same process will be tried on some of the treeless plains to the north." With a view to proper protection of the young plantations, a beginning has been made in the establishment of a college where young men will be trained in woodcraft and forestry, and in agricultural chemistry. By these praiseworthy means it is hoped that the climate of the colony will be ameliorated, and the ever-increasing tendency towards drought—which is the invariable accompaniment of a treeless district—arrested.

A Fast Cement.—A very valuable cement has been discovered by Mr. A. C. Fox, of which details are published in *Dingler's Polytechnisches Journal*. It consists of a chromium preparation and isinglass, and forms a solid cement which is not only insoluble in hot and cold water, but even in steam, while neither acids nor alkalies have any action upon it. The chromium preparation and the isinglass or gelatine do not come into contact until the moment the cement is desired; and when applied to adhesive envelopes, for which the author holds it to be especially adapted, the one material is put on the envelope covered by the flap (and there not touched by the tongue), while the isinglass, dissolved in acetic acid, is applied under the flap. The chromium preparation is made by dissolving crystallised chromic acid in water. You take:—

	Grammes
Crystallised chromic acid ...	2·5
Water	15
Ammonia	15

To this solution about ten drops of sulphuric acid are added, and finally thirty grammes of sulphate of ammonia, and four grammes of fine white paper. In the case of envelopes, this is applied to that portion lying under the flap, while a solution prepared by dissolving isinglass in dilute acetic acid (one part acid to seven parts water) is applied to the flap of the envelope. The latter is moistened, and then is pressed down upon the chromic preparation, when the two unite, forming, as we have said, a firm and insoluble cement. In the case of mounting cartes-de-visite or other photographs, it would perhaps be wisest to apply the chromic preparation uniformly to the mounts first of all, and permit these to dry, when they would be ready for use at any moment. The print would then merely have to be faced with the solution of isinglass and acetic acid, and pressed to the mount. We have ourselves no practical experience of the cement, but it would be well worthy of trial by photographers.

Economy of Fuel.—Mr. Emerson Bainbridge read a paper before the British Association, on an experiment made to ascertain the cause of the difference between the quantity of heat in fuel and the quantity which is utilised in the work done by a steam-engine. He said that the most economical mode of producing and using steam power formed a question of special interest at the present day for engineers, this leading to the problem as to the scope that might exist for the utilisation of the large margin of loss in the difference between the heat contained by the fuel and the small percentage of such heat which is represented by the work actually performed by a steam-engine. Only 11 per cent. of the actual heat power contained in the fuel was utilised, and though a large proportion of that loss could never be overcome, the importance of the inquiry was evidenced by the fact that every 1 per cent, gained means in the consumption of this country alone a saving of about half a million tons per annum. About 50 million tons were annually used in the production of steam, which was about 37 per cent. of the whole output. The coal used in dwellings, great as was the waste, was more fully utilised than when it was used in any other way : thus 13 per cent. of the heat actually possessed by fuel was given off in an open fireplace. As an instance of the small amount of heat utilised, it was stated that to produce 3lb. of steel 7lb. of coal were required.

The author then gave the results of an experiment he had made with the winding engine and boilers of a small colliery, such plant being nearly 30 years old. Some of the improvements which might be made with a view to promoting economy of fuel were the fixing of boilers of an improved construction with a minimum thickness of plates and a maximum area of heating surface. Special attention should be paid to the manner in which air is admitted to the fire, and to the working of the damper. The air in the firegrate should be so intermingled with the gases from the fire as to enable a minimum quantity of air to be used. The ap-

plication of such form of firegrates and such mode of firing as will enable the cheapest quality of fuel to be used; the complete covering of all exposed surfaces; where water is scarce, the application of the best form of water-heater; where water is plentiful, the adoption of an improved form of condenser; steam-jacketing of the cylinder and mechanical accuracy in the construction of the engine; the application of the system of variable expansion when the work done by the engine varies; in case of winding engines, the adoption of drums of varying diameter; as a general principle, the use of steam at a high temperature, in order to have the greatest possible difference in temperature between the steam when it reaches the cylinder, and when it has done its work. In the application of such improvements to ordinary steam-engines, the saving in working cost must, of course, first be considered, and in the adoption of all such means of promoting economy as have been alluded to it may be confidently asserted that the saving in working cost will, as a rule, wipe off the extra first cost incurred in a very short time, since the saving effected will probably vary from 50 to 150 per cent. per annum on the first cost.

The Mineral Statistics of the United Kingdom.—The Mineral Statistics of the United Kingdom for 1878 have been issued by the Keeper of the Mining Records, Mr. Robert Hunt, F.R.S. The total value of the minerals produced last year was £56.264,495, more than £2,000,000 below the value of the minerals raised in 1877 (£58,398,071). That year already showed a small diminution as compared with 1876, the total for which was £58,691,832; and so low a return as the present has not been known since 1871. Half of the total decrease in the produce of 1878, as compared with that of 1877, is attributed to a diminution in the supply of iron ore, and the greater proportion of the remainder to a decrease in the production of coal. The statistics of coal production given by the Keeper of Mining Records do not, however, always tally with those contained in the reports of the inspectors of coal mines. With regard to the past year, there is no noticeable discrepancy; but in 1877 the returns varied from 134,610,763 tons, the figures given by the Office of the Keeper of the Mining Records, to 132,179,968 tons, the return of Her Majesty's Inspectors. The amount of coal which, according to both sources of information, was raised in 1878, exceeded in amount 132,600,000 tons, and was of the value of £46,412,753. It is needless to say that these values are calculated at wholesale prices. Iron ore to the extent of 15,726,370 tons, worth £5,609,507, was raised. Iron and coal are, of course, the main sources of our mineral wealth, and nothing else approached the amount contributed to the total by these two minerals.

The next largest item was furnished by the salt-works. Of salt, 2,682,930 tons, valued at £1,341,465, were extracted from mines and springs. The production was 20,000 tons less than in 1877, and the value £150,000 less. There were obtained 77,350 tons

of lead ore, of the value (less by 3,000 tons and £400,000 than in 1877) of £801,428; and the clays, for the use of potters, for making porcelain, or for the purposes of fire-clay, realized £677,871, at an average rate of about 5s. a ton for 2,711,486 tons. In 1877 the average price was 20 per cent. lower, and the yield a little more. Of tin ore a larger quantity, at a lower price, was raised in 1878 than in 1877. Last year's return was 15,045 tons, at £530,737. The produce of 1877 was 14,142 tons for £572,673. Other figures for 1878 may be more briefly referred to. Sundry minerals, including shales, gypsum, calc, spar, coprolites, and phosphates, realized £512,000 from a production of 778,029 tons. Copper ore decreased considerably in amount (from 73,141 tons to 56,094), and the 56,094 tons raised brought £201,434. Zinc weighing 25,438 tons, and worth £80,565, was raised. Barytes produced £36,688 for 22,435 tons; arsenic, £26,900 for 4,991 tons; iron pyrites, £19,099 for 29,867 tons. It will be observed that by far the largest amounts are furnished by the cheapest of the minerals. Silver realized £5,994 from 94 tons 9cwt. of silver ore. This does not exhaust the yield of silver, for that widely-spread metal, which is detected in the waves of the sea, was also extracted in paying quantities from the lead ores. Ochre and umber worth £4,038, and weighing 4,414 tons; manganese, estimated at £3,120, for 1,586 tons; nickel ore, valued at £616, for 98 tons 18cwt.; fluor spar weighed at 391 tons, and sold for £133; 10 tons of wolfram, worth £100; and, finally, 8cwt. of uranium, valued at £44, complete the list. The ores produced in the United Kingdom turned out 702oz. of gold, valued at £2,848; 6,381,051 tons of pig iron, worth £16,154,992; 10,106 tons of tin, worth £663,080; 3,952 tons of copper, worth £271,042; 58,020 tons of lead, valued at £972,491; 6,309 tons of zinc, valued at £123,025. Silver was obtained from lead to the amount of 397,471oz., and the value of £88,296; from silver ore the amount was 27,648oz., and the value £6,223.

Mr. Hunt observes that as an authority which commands respectful attention has raised the question of the comparative values of the two systems under which the mineral returns are obtained, he feels it necessary to say a few words as to the completeness of the information contained in the annual volume issued from his office, which depends entirely on voluntary returns. Under the Metalliferous Mines Regulation Act, 1872, the inspectors are empowered to compel returns, on or before the 1st of February in each year, of all the minerals raised from all mines or underground workings. They cannot require returns of mineral produce obtained by open workings or in quarries, such as tin ore obtained by washing alluvial deposits or the like; and they have no power to seek the quantities of iron ores or of any other mineral obtained from shallow beds. They are officially unable to give the money values of any of the metallic ores or earthy minerals, or to state (which is more important) the

percentage of the metal contained in the ores, upon which their commercial value depends. Each one of these matters will be found fully given in the Mineral Statistics. It is scarcely necessary, he adds, for him to say that nothing can be more satisfactory than the reports of the inspectors, so far as the Acts of Parliament empower them to press their inquiries.

The summary returns of which we have given the heads are founded upon a vast amount of information relating to particular localities and trades, which is scattered through an octavo volume of 218 pages. Some particulars are also given of foreign mineral production. 'The deliveries of Banca tin in Holland and the sales of Billiton tin in Batavia are noted. The average of the copper standard in Cornwall since 1874 is given. The average has varied, year by year, from £97 16*s.* to £110, £113 8*s.*, £103 3*s.*, and £86. Northern Spain entered into the iron-ore market to a considerable extent. The export from Bilbao of iron ores last year amounted to 1,224,730 tons.

The mean price of coal in the London market for the year was 16*s.* 4*d.*; the mean price at the pit's mouth in Cumberland was 8*s.* 6*d.* This price relates to all coal, not household coal merely. The amount of coal exported from the United Kingdom was 15,494,633 tons, and its declared value was £7,330,474. In 1877 the amount was 15,429,050 tons, and the value £7,884,486. The result shows lower earnings for more work done. The home trade in coprolites and phosphatic nodules has fallen off. The manure manufacturers now depend chiefly upon foreign supplies. The port of Charlestown, in America, is supposed to supply 170,000 tons yearly, of the value of £500,000; and other places send to the value of £200,000. The English production (the seats of which are in the Suffolk crag; in the upper greensand, with a base of chalk marl, of Cambridgeshire; and in the lower greensand of Bedfordshire) having become of small importance, the returns are difficult to procure. A list of all the mines in the United Kingdom concludes the book. The production of this volume continues a series which has been published regularly since 1848, and is of great usefulness for the purposes of comparison.

The Hygienic Conditions of Coal Mines.—Some interesting information as to the way in which the human system is affected under the peculiar conditions of work in mines has been furnished by Dr. Fabre, from experience connected with the mines of Commentry, Allier, in France. The deprivation of solar light causes a diminution in the pigment of the skin, and absence of sunburning, but there is no globular anæmia—*i.e.*, diminution in the number of globules in the blood. Dr. Fabre infers this from some 400 experiments in which the globules were counted in the microscope by a well-known method. It might be thought this absence of true anæmia might be accounted for by the men being out of the mine 14 hours out of the 24, and all day on Sunday. But it is found that the blood of

horses in the mine is quite similar in the number of globules to that of horses above ground, having similar work and food, and these animals are kept in the mines all the year round, except when they are brought up once a year for the general inventory. Internal maladies seem to be more rare, and surgical operations more frequent in the horses underground than those above. While there is no essential anæmia in the miners, the blood globules are often found smaller and paler than in normal conditions of life. This is due to respiration of noxious gases, especially where ventilation is difficult. The want of oxygen is in the air, which does not supply enough of it to the globules, whereas in globular anæmia the globules are too few to bring enough oxygen to the tissues. The horses do not show the kind of anæmia observed in miners, because they work in large and well-ventilated passages.

The increase of atmospheric pressure in the Commentry mines is not such as to cause any appreciable physiological disorders, and the ventilation prevents accidents from confined air. The moisture, which is generally excessive in mines, does not incommode or act injuriously on the miners so long as the temperature does not exceed 25 deg., but when this is exceeded they are very quickly fatigued, and cutaneous eruptions often appear on them. In the spontaneous combustions which frequently occur in the mines, the men work in rapidly successive relays to confine the fire, and they experience little more than muscular fatigue, if the air has been pretty pure. The most frequent irrespirable gases are carbonic acid (abundant in these mines), carbonic oxide, ammoniac gas, carburets of hydrogen, and (where the coal contains much iron pyrites) sulphurous and sulphhydric acids. These are mostly well carried off by ventilation. The men who breathe too much the gases liberated on explosion of powder or dynamite suffer more than other miners from affections of the larynx, the bronchia, and the stomach. Ventilation sometimes works injury by its cooling effect. Bronchitis is extremely common among the coal miners, also vesicular emphysema, these affections being aggravated by the coal dust. On the other hand, pulmonary phthisis seems to be very rare. In six years Dr. Fabre did not meet with more than two cases of deaths from this cause among 1,800 miners. It appears generally that working in the mines of Commentry is rather laborious than unhealthy: it is certainly not to be compared with those frequent operations in which powder containing lead or mercury is breathed.

Blast-Furnace Slag.—Scattered throughout the iron-making districts of Great Britain are many millions of tons of scoria or refuse from the blast furnaces, which is technically known as slag. This slag goes on accumulating at the rate of nearly eight millions of tons per annum, its bulk being some three times that of the iron from which it has been separated. It forms a heavy incumbrance to ironmasters, demanding the purchase of large tracts of land whereon to deposit it, the invest-

ment being, of course, wholly unremunerative. There are one or two exceptions to this rule, as at the Barrow Hematite Iron Works, where the slag is tipped into the sea and serves to form land for the works, and at Middlesbrough, where some of the iron works supply slag for the construction of the breakwater and training-walls in the river Tees. The quantity thus utilised, however, on the Tees is but about 600,000 tons per annum, forming only a small proportion of the whole yield of the district. In some cases where the iron works are conveniently situated, the slag is carried out by barges and tipped on to banks at high water to form training-walls, or for reclaiming land, being thus got rid of. But as a rule, the labour and capital expended upon this unproductive substance tell heavily upon profits.

No wonder, then, that from the first persistent efforts have been made either to utilize it or to get rid of it altogether. In early times slag was broken up by hand and used for road-making, and it so continues to be used where it can be had without a heavy cost for transport; but there is only a limited demand for it for this purpose. On the continent, where stone is scarce, slag plays a prominent part in road-making, as in Silesia and other similarly situated districts. Another direction in which many attempts have been made to utilize slag, both at home and abroad, is to adapt it for constructive purposes, and various schemes have been devised for transforming the highly refractory slag into bricks, sand, and other materials for building. Some of these schemes have proved successful within certain limits; but the peculiar nature of the slag has more generally led to failure, owing either to the difficulty of dealing with it or to the attendant expenses.

Among the most prominent living scientific investigators of the question was Mr. Bessemer, and about 15 years since Mr. John Gjers devised a method of granulating slag, the sand produce being used in place of silicious sand on the pig beds. The practice, however, was discontinued after a time for technical reasons. Several other practical men have taken an active part in endeavouring to solve the slag difficulty, among them being Mr. D. Joy, Mr. T. Bell, Mr. Lurman, and Mr. Homer. Some time since Mr. Charles Wood, of Middlesbrough-on-Tees, directed his attention to the utilization of this unproductive material, and after about five years of careful study, experiment, and practical research he has succeeded in effecting the conversion of blast-furnace slag into various forms, and in applying it to several industrial purposes upon a practical and commercial scale. At the time when he started upon his investigations there was no instance of slag being manufactured into a commercial commodity in this country, its only known application being that of road-making. Mr. Wood, however, has succeeded in utilizing it for the manufacture of building bricks, concrete, cement, mortar, and slag-wood. The various processes of conversion and manufacture are carried on under Mr.

Wood's management at the Cleveland Slag Works at Middlesbrough, which, together with the adjoining Tees Iron Works, belong to Messrs. Gilkes, Wilson, Pease, and Co., of which latter works Mr. Wood is also the manager, and whence the slag is obtained.

In following the highly interesting processes of conversion consecutively, we must take our readers to the iron works, where the slag is run from the blast furnaces into two different machines, one of which produces a coarse kind of shingle and the other a fine sand. For making shingle the liquid slag is run direct from the blast furnaces on to a circular, horizontal, rotative table, composed of thick slabs of iron kept cool by having water circulated through them. The table, which revolves slowly, carries the slag round to a certain point, by which time it has solidified. At that point it encounters a stream of water, which further cools it, and soon after it comes against a set of scrapers, which break it up and clear it off the table, delivering it into waggons placed below, and which convey it away. For producing slag sand, the slag is run from the blast furnace into a hollow wheel revolving upon a horizontal axis and fitted with iron buckets inside. A bath of water is maintained inside the wheel at the bottom, and is kept in a state of violent agitation by the revolving action. As the molten slag enters the body of water it is immediately disintegrated and assumes the form of sand, the water taking up the heat from the molten slag and giving it off in the shape of steam. A constant flow of water is maintained into the machine, and the sand is separated from it and elevated to the top of the machine by the bucket plates, which are perforated Arrived at the upper part of the machine, the slag sand is dropped into a spout, and thence finds its way into wooden waggons, by which it is conveyed to the slag works for manufacture.

The slag works occupy a main building 120 ft. long, 50 ft. wide, and 5 stories high, with basement beneath, and engine-house, boiler-house, and other accessories annexed. This building was constructed of slag cement-concrete, composed of four parts of slag shingle to one part of cement and it forms a very solid and comparatively indestructible structure. The slag sand is brought here from the blast furnace and is tipped into stores below, whence it is elevated to the top floor by means of a hoist, which is fitted with an ingenious automatic safety brake designed by Mr. Wood. The special manufacture in this building is that of bricks, and in carrying this out two machines are used, one having been designed by Mr. J. J. Bodmer and the other by Mr. Wood. For the Wood machine the sand is delivered into a hopper through a coarse screen, which retains any pieces of slag or other substances which may have found their way into the sand. Arrived at the floor below, the sand is automatically measured on a revolving cylinder, divided on the outside, and placed at the bottom of the hopper. From another hopper selenitic lime in powder is also

measured by a similar contrivance, and the two substances unite in one shoot, where they become mixed in the proportion of ten parts of sand to one of lime.

The mixture is carried down through a hopper into the pug-mill of the brick-making machine, where the two substances are further incorporated. This machine was designed by Mr. Wood, and is the outcome of considerable experience with another machine to which we shall presently refer, and which it has to some extent superseded. Mr. Wood's brick-machine has a horizontal, circular, rotating moulding table, which contains six pairs of moulds, four bricks being pressed at the same time. During the time of pressing—which is effected by direct mechanical pressure—the table remains stationary, and at the same time four other moulds are being filled, and the remaining four are delivering the pressed bricks. As they are delivered they are taken off the machine by two girls, and are removed to an air-drying shed — the machine producing from 11,000 to 12,000 bricks per day. There they remain for a week or ten days, after which they are stacked in the open air to harden, which occupies another five weeks or so, when the bricks are ready for the market. The bricks thus produced are very tough; they do not split when a nail is driven into them, and are largely used for interior work, for which they are well adapted from the regularity of their surface and other qualities. They find a good market in London, and are not subject to breakage in transit. According to a certificate recently issued from Kirkaldy's testing works, some bricks taken from a stock three years old were not crushed until a pressure of 21 tons had been reached. Others taken from a stock four months old were crushed with 9 tons pressure, thus showing not only unusual toughness and strength, but that they were greatly improved by age. We thus have the curious anomaly of bricks being made without burning, and of a wet season being favourable to the hardening process.

The second machine at the Cleveland Slag Works is that of Mr. J. J. Bodmer, and was the first one put up at the works. It is worked by hydraulic power, and has a horizontal revolving table with 12 moulds. The slag sand and the lime are mixed on their way to the machine, but the machinery for effecting the mixing is more complex than that used for Mr. Wood's machine. The rate of production in the Bodmer press is about the same as in the Wood machine, the distinctive difference between the two presses being that the former is worked by hydraulic power and the latter by direct mechanical pressure, Mr. Wood's machine possessing several advantages over that of Mr. Bodmer.

In another department the manufacture of artificial stone is carried on, the stone being moulded into chimney-pieces, window-heads, balustrading, and outside ornamental builders' work generally. The stone is composed of two-and-a-half parts of finely pulverized slag and two-and-a-half parts of ground brick to one

part of Portland cement. The mixture is run into moulds and sets quickly, the articles being ready for the market in four or five days. Besides bricks and stone articles, the slag is used for making mortar, cement, and concrete. The mortar is a mixture of slag and common lime, the cement being composed of the same materials with the addition of iron oxides. Slag cement also forms the subject of a recent invention by Mr. Frederick Ransome, who has produced some very remarkable results. His cement consists of a mixture of slag sand and carbonate of lime in the proportion of two parts of lime to one part of slag sand. These are burnt together, and experiments show the result to be a cement possessing nearly 30 per cent. greater strength than Portland cement.

Perhaps the most beautiful, and certainly not the least remarkable, outcome of blast-furnace slag is slag wool, or silicate cotton as it is also called, owing to its resemblance to cotton wool. The process originated, we believe, with Messrs. Siemens Brothers, on the Continent, and the manufacture has been before attempted in England, but, as far as we are aware, has not succeeded. As carried out by Mr. Wood at the Tees Iron Works, a jet of steam is made to strike against the stream of viscous molten slag as it runs off from the blast furnace. This jet scatters the molten slag into a stream of shot, which is projected forward near the mouth of a large tube, in which a couple of steam jets cause an induced current of air. This tube opens into a receiving chamber, composed chiefly of wire gauze, and measuring about 33 ft. long by 15 ft. wide, and 12 ft. high. As each shot leaves the stream of slag it carries a fine thread or tail with it. The shot, being heavy, falls to the ground, while the fine woolly fibre is sucked through the tube and deposited in the chamber. The appearance of this chamber after a charge has been blown into it is singularly beautiful. Not an inch of floor, sides, or roof but is covered with a thick layer of the downy silicate cotton, bringing forcibly to mind the familiar words of the old 147th Psalm—

"Large flakes of snow like fleecy wool."

After each blowing the wool is removed by forks, and packed in bags for consignment to a London firm—Messrs. Daniel Dade and Co.—who make it into mattresses which are used for covering steam boilers, and for other purposes where it is desired to prevent the radiation of heat. For this purpose slag wool is eminently adapted, as it is a very bad conductor of heat, and is, moreover, perfectly incombustible. The make of slag wool at the Tees Works is about three tons per week, and as during the running of a 4-ton slag ball about 1¼ cwt. of slag-wool is made, it follows that for producing these three tons nearly 200 tons of slag have to be operated upon.

Another useful purpose for which blast-furnace slag has been successfully utilized is that of glass manufacture. The vitreous character of slag indicates a resemblance to glass in its com-

position. It does, in fact, contain the principal components of glass, but not in proper proportions, and those in which it is deficient have therefore to be added, with others which are not present. Some years since Mr. Bashley Britten investigated this question, and in the end succeeded in utilizing for the manufacture of glass not only the material but the heat of the slag. This latter is a very important point, inasmuch as upon it depends the economy of the utilization, and therefore its commercial success. The practical result of Mr. Britten's researches was the establishment by a company of some works at Finedon, in Northamptonshire, where the manufacture of glass bottles from slag is now and has for some time past been regularly carried on. The glass works are situated in close contiguity to the blast furnaces of the Finedon Iron Works, where the Northamptonshire ore is worked, and as the molten slag is run from the furnaces it is conveyed in carriers to the glass works. In these works a Siemens regenerative gas furnace applied to a gas melting tank enables the preparation of the "metal" to be carried on continuously, affording a constant supply to the glass-blowers. The ingredients of the glass are fed into the tank in charges of about 500 lb., the larger half of which is the molten slag, the remainder being the other necessary ingredients, such as sand and alkalis. In the tank these substances are fused and fined, the fused metal flowing through a bridge to the other end of the tank, where there are five working holes, from which the metal is taken by the workmen and fashioned into useful articles in the usual way.

For the present the manufacture is confined to wine and beer bottles, of which about 90 gross can be produced per day. So far the results have proved sufficiently satisfactory to induce the company to extend their works. It is proposed to erect additional furnaces, and to manufacture other articles besides bottles, and for these a wide field opens itself. The glass produced is said to be stronger than ordinary glass, and the colour can be varied as required, the natural tint being green. Its working qualities are said to be of the highest order, as it comes from the furnace in the best possible condition for the worker. Some bottles made at Finedon were sent to the Paris Exhibition of 1868, where they obtained honourable mention, a testimony at once to their character. A new method of toughening glass has recently been discovered by Mr. Frederick Siemens, of Dresden, and it is proposed to apply this process to slag glass for the purpose of manufacturing railway sleepers and other articles. Details of Mr. Siemens's process are not at present to hand, but, judged by results, it would appear to differ from that of M. de la Bastie, inasmuch as when the toughened glass is broken it does not fly into minute atoms as does De la Bastie's, but simply fractures, somewhat similarly to cast iron.

We have now taken our readers through these various interesting and ingenious processes, which

are being carried on as ordinary commercial pursuits. The successful utilization of slag has a double importance—it not only helps to reduce the annual accumulation of a cumbersome and worthless waste product, but it adds new branches of manufacture to the industrial arts. Mr. Wood may be complimented on his perseverance, and congratulated upon his success. When in full work 450 tons of slag are produced per day at the Tees Works, and of this quantity about 1,000 tons per month are converted into sand for brick-making, the average make with the two machines going being 110,000 bricks per week, the whole of which now find a ready sale in the London market. We should mention that slag bricks are also being made at the Moss Bay Iron Works, by Messrs Kirk Brothers, who reduce the slag to powder first under edge runners, and then pass it between millstones. The powder is then moistened and pressed into bricks, which are hardened in the open air. The bricks are very good, but they are heavy, and are said to be expensive. At the Acklam Iron Works blocks for paving streets, stables, and the like are being made from slag. The slag is there run into heated moulds, and after each block is formed it is removed from the mould and placed in ovens to anneal. These blocks are heavy, but wear well. In view of the general usefulness of the slag when converted into the various articles we have described, it is to be hoped, in the interests of commerce and progress, that the practice of its utilization may become more and more extended. Doubtless human progress will show that what is now the veriest waste may, in the course of time, assume a condition of value. Thus will art be made to approximate to nature in that it will know no waste.—*Times.*

Recent Advances in the Applications and Science of Photography.—Classed among the industries of Great Britain, it may be fairly presumed that photography has in recent years made some advance both in simplification of process and in its applications to commercial purposes; and if we compare its present condition with that of ten years ago, the presumption is fully borne out. Yet, if we take any particular year of the decade, it will be found impossible to allot to it any important forward step as regards the art-sciences—a sure sign that the progress made has been steady rather than rapid or in bounds. Ten years ago, for instance, our bookstalls were not adorned with periodicals whose *raison d'être* appears to be the publication of photographic prints of certain celebrities, nor did we find biographies and books of travels illustrated with photographs of persons and places, nor yet an artist's pen-and-ink sketch reproduced in facsimile by the action of light on a metal relief-block or engraved plate. To-day all of these applications of photography are common enough, and excite no surprise. The uninitiated, however, are little aware of the costly experiments, and often unrequited labour, which have been entailed in order to bring them to a suc-

cessful issue. In scarcely any industry has capital been more unremunerative, or the public so little appreciative of merit.

Since the price of the weekly or bi-weekly papers, which are illustrated with, in some cases, really admirable portraits, is only a penny or twopence, it is not hard to understand that some cheap method of multiplying the photographs must have been discovered. Moreover, it must evidently be one which possesses marvellous delicacy, since the prints show all the delicate tints representing light and shade which rival the well-known silver productions. The process answering these requirements is the Woodburytype, so called from its clever inventor, and it will not be out of place to give a general outline of it. It may be said to be based on the production of a "squeeze" or mould in soft metal from a photographic print, in which the gradations of light and shade are represented by differing thicknesses of gelatine. Into such a mould, which shows all the minutest differences in level of the original print, liquid and coloured gelatine is poured, and the excess is squeezed out by a flat plate being brought to bear on the paper, under which the mould and its contents are placed in a suitable press. The "shape" of jelly when set is removed with the adherent paper, and is allowed to dry, the metal mould being again available for a similar operation. Here, then, we have a means of producing prints by the thousand from photographic *clichés*, or negatives, the cost of production being principally dependent upon the price of the coloured gelatine and of the labour.

There are other mechanical photographic printing processes before the public which are not used to such a large extent as the Woodburytype, being patronized more for commercial advertisements than for art purposes. To these may conveniently be given the generic name of "collotype," since the prints consist of surface impressions taken from a gelatine film without the intervention of a metallic mould. We have seen how in Woodburytype a gelatine image in relief is necessary to form a stamp for the mould, but in these we have the image lying in a film of insoluble gelatine, and showing its presence by the difference in absorption of water by the light and shades. When such an image is produced in a film of gelatine and is moistened, it can retain greasy ink in exactly the inverse proportion to that in which it retains the water; and if lithographic ink be applied to it by means of a roller, a black picture, in all its gradations, is formed, capable of being transferred to paper by pressure in an ordinary printing-press. A certain amount of trained skill in applying the ink is required, and these processes are not, therefore, perfectly mechanical in practice, something being dependent on the judgment of the printer. They are, however, excellent as applied to photographs of machinery, trade articles, and landscapes, while for portraits they are rather uncertain. The carbon process, exemplified in such perfection by the Autotype Company, is too well known to need any description.

XII.—MISCELLANEOUS.

The Praxinoscope.—The Zoetrope and the Phenakistiscope are well-known toys in which a number of drawings representing the same objects in different positions are made, by rapid motion, to present the appearance of moving objects. In a new instrument, devised by M. Reynaud, and called a Praxinoscope, there is no interruption in the vision nor sensible reduction of light, and the eye is enabled to view continuously an image which is incessantly changing. M. Reynaud resorts to a substitution of virtual images. The Praxinoscope consists of a circular case, open above, on a vertical axis, and having a series of figures representing the phases of the action round its interior circumference. Midway between this and the centre is a concentric circle (or rather polygon) of plane mirrors, each mirror corresponding to one of the figures. A gentle motion of the system round the axis produces the substitution of the images in the mirrors, and the animated illusion is produced admirably.

A New Alarum Clock.—A new alarum clock, patented in Germany by Herr Hummel, presents some advantageous features. It will give an alarum at several hours in succession without any fresh arrangement, and on this account is specially useful for railway officials and nurses. The alarum continues sounding till the person roused pulls a little cord, the hands can be moved either forward or back without injury to the mechanism, &c. The general arrangement is this: Within the principal figure-plate is a second smaller movable one, which rotates exactly once in 24 hours. The figures are here in reverse order to those on the chief figure-plate, and those on the white ground correspond to day hours (7 a.m. to 6 p.m.), those on coloured ground to night hours (6 p.m. to 7 a.m.). Within the figure-circle of the second plate is a concentric circle of small holes corresponding to hours and quarters. A number of pegs are kept below on the outer border of the chief figure-plate, and you have merely to stick these into the small hole or holes corresponding to the times at which you wish to be awaked. The clock goes eight days. The alarum weight does not require to be wound up oftener than once in three months if the alarum be called into action only once daily.

Preserving Leaves and Green Fruits in Salt Water.—A remarkable case of preservation of leaves and green fruits in salt water is described by M. Alph. De Candolle in *Archives des Sciences*. A friend, M. Mercier, received, fifty-three years ago, from Havana or Martinique, a branch of a coffee-plant, with fruit still green, in a bottle said to con-

tain salt water. M. Mercier gave the specimen to the elder De Candolle, and M. Alph. De Candolle kept it carefully on account of its perfect transparency and the persistence of the colours. He had grave doubts as to whether the liquid was simply salt water, and all the experiments he made to preserve plants in this way failed — the water becoming troubled, and the vegetable matter losing colour. Last spring the water began to evaporate, some of the resin having come off the stopper. He then opened the jar, and on analysis of the liquid by a chemist it appeared to be what was stated. The absence of gas, however, proved that the solution had been boiled, and poured while hot into the jar. The author is surprised that the air and ferments in the plant did not work a change, and he asks if the branch may not have been prepared in some way before immersion; also if the water may not have been renewed several times before closing. Experiments are desired on this subject. Alcohol or borax is used for preserving vegetable matters in museums, but marine salt would have undoubted advantages, being so easily procured and cheap, and giving no trouble like alcohol, which has to be renewed from time to time, and which sometimes tempts sailors on board ship, or workmen in museums, to drink it. Borax, too, dissolves colouring matter from plants.

Extinction of Fires.—A French chemist, M. Queynet, has devised a method of rapidly extinguishing fires in chimneys. It consists in burning about 100 grammes of the sulphuret of carbon on the hearth of a chimney, the sulphur being first turned into one or two broad hollow plates, in order that the combustion may be produced on a relatively large surface. Chimney fires, so numerous in Paris as well as London, have usually been extinguished, in Paris at least, by the firemen by means of sulphur burnt on the hearth of the chimney; but it is almost always necessary to mount to the roof to close the orifice at the top. On the other hand, if the temperature of the hearth be very moderate, the sulphur burns with difficulty, and melts, being transformed into brown sulphur, and its combination with oxygen is so slow that there often remains sufficient oxygen in the air which the vent contains to enable the soot to continue to burn. M. Queynet's idea is to employ for the extinction of fires in chimneys a body which in burning gives, like sulphur, sulphurous acid, but in conditions much more advantageous than powdered sulphur. In fact, the sulphuret of carbon, a liquid combination of sulphur and carbon, vaporises and inflames very easily, burns very quickly, and yields, by absorbing the oxygen of the air, a gas composed of two-thirds of sulphurous acid and one-third of carbonic acid, both equally unfavourable to combustion. As to any danger connected with the method, this can be avoided by very simple precautions. The liquid should be divided into quantities of 100 grammes, in flasks large enough to preserve a vacuum, to allow for the great expansion of sulphuret of carbon. The firemen of Paris

have thus extinguished in January of 1879, 32 out of 51 fires; in February, 81 out of 103; in March, 138 out of 165; or, in all, 251 out of 319 fires. And these 251 extinctions have been to some extent instantaneous, without the necessity of mounting the roof, or in any way disarranging the apartments.

To Restore the Blackness of Old Leather.—For every two yolks of new-laid eggs, retain the white of one; let these be well beaten, and then shaken in a glass vessel till as thick as oil. Dissolve in about a tablespoonful of Hollands gin a piece of lump sugar, thicken it with ivory-black, and mix the eggs for use. Lay this on in the same manner as blacking for shoes, and after polishing with a soft brush, let it remain to harden and dry. This process answers well for ladies' and gentlemen's leather shoes, but should have the following addition to protect the stockings from being soiled. Shake the white or glaire of eggs in a phial till it is perfect oil, and lay some of it out twice, with a small brush over the inner edges of the shoes.

Ancient Art and Ancient Geometry.—A paper on "The Connection between Ancient Art and the Ancient Geometry as illustrated by Works of the Age of Pericles," read before the Institute of British Architects, is well worth study by those who wish to acquaint themselves with the principles on which architecture as a progressive science is based. The examples are taken from the buildings now standing in ruin on the Acropolis of Athens. The builders thereof, says the author of the paper, Mr. Pennethorne, had "a few elementary proportions, and four or five distinct forms of curved lines, and with these simple materials, combined respectively, works of Art were produced that are quite worthy of a place along with the Greek works of geometry and literature. . . . The arts were then united with the geometry, and with the highest intellectual culture; whereas we find in India, in Assyria, and, in the middle ages, in Europe, that architecture everywhere attained a certain degree of excellence, suited to the climate and to the wants of society, and then became stationary and decayed; for without the geometry it could not advance beyond the first elementary state, and there was no power to refine and perfect the first ideas. It was not until the European mind in the fifteenth century was linked again to the ancient stream of geometry and philosophy that a real advance was made in any branch of modern science; and probably no real progress will be made in architecture until we can completely recover and freely use the accumulated knowledge of the ancient world in all that relates to the science of art, and make it a basis and a starting-point."

A New Calculating Machine.—Sir William Thomson has added yet another to his admirable inventions of philosophical instruments by producing a Machine for the Solution of Simultaneous Linear Equations, which, as is obvious, appeals to mathematicians, by whom alone it can be properly appreciated. To give an

intelligible explanation of it to unlearned readers would hardly be possible; but an idea of its capabilities may be gathered from Sir William's description, as read before the Royal Society. "The actual construction," he says, "of a practically useful machine for calculating as many as eight or ten or more of unknowns from the same number of linear equations does not promise to be either difficult or over-elaborate. A fair approximation being found by a first application of the machine, a very moderate amount of straightforward arithmetical work suffices to calculate the residual errors, and allow the machine to be re-applied to calculate the corrections. . . . There is of course no limit to the accuracy thus obtainable by successive approximations. The exceeding easiness of each application of the machine promises well for its real usefulness, whether for cases in which a single application suffices, or for others in which the requisite accuracy is reached after two, three, or more of successive approximations." A description of this remarkable self-correcting machine is printed in the *Proceedings* of the Royal Society.

Japan Tea.—The competition of Japan teas with those of China and Assam has quite recently received a new impetus. In a recent report on the tea trade of Hiôgo we are told that efforts are being made to stimulate this important native industry by the manufacture of black tea. This, it is stated, is of the greatest importance to Japan in view of the strong competition which exists between teas produced in the country and those known in trade as Formosa Oolongs, the only great market for both of these kinds being America, the effect of which has been to reduce prices, and, consequently, to impose a limit upon production. Several hundred piculs of imitation Congou were shipped to London from Hiôgo in the course of last year, and are said to have been favourably received in the market, both quality and flavour being of a high order. The only question remaining to be solved as to the success of these teas is whether they "can be produced at prices low enough to enable them to compete favourably in foreign markets with China and Assam teas."

King Alfred's Palace.—Mr. Hunt, hon. secretary of the Somersetshire Archæological Society, during the year reported an interesting discovery at Wedmore. It is scarcely needful to remind those interested in such matters that before the Conquest, Wedmore was the site of one of the palaces of the English Kings, and that the place belonged to the Crown. It was there that the great peace was made with the Danes in 878, and the chrisom-loosing of Guthorm was kept. In Sept. 1878 the 1,000th anniversary of this event was celebrated at Wedmore under the auspices of the Bishop of Bath and Wells. Wedmore remained the property of the Crown until it was given to the See by Edward the Confessor, and at the same time Mudgeley, a hamlet of Wedmore, was granted to the Bishop by Lady Eadgytt, the Queen of Edward. Tradition has pointed

out a certain field in Mudgeley, about a mile from Wedmore Church, as the site of the old palace. This is called the Court Garden, and there are many stories of the treasure which is said to be hidden there. Mr. Sydenham Hervey, the rector, and son of Lord Arthur Hervey, the Bishop of Bath and Wells, has lately made some excavations in this field. Extensive remains of a building have been found—not mere foundations, as the walls are in some places plastered on the inside. The walls are massive, the mortar of an ancient character, and the whole appearance of the building speaks its great age. A large quantity of pottery has been found, some Roman and some of an early English character—one piece, a small and perfect female face, probably the mouth of a jar; handles of some vessels of the shape of amphoræ, several bits ornamented with a rude band of leaves, &c. As yet no coins have been found. Some of the walls are buried at a depth below the surface of the land of 6 ft. to 10 ft.; others, which are on rock, are but thinly covered with earth. There can be little doubt but that Mr. Hervey has discovered the remains of the old palace of our West Saxon Kings, the very scene of the high festival at which, 1,000 years ago, the peace was signed with the Danes, and the fillet was loosed from the brow of Guthorm, or rather Æthelstan, to call him by his new Christian name. The character of the pottery and the shape of some of the shingles which have been found seem to point to the probability that the old English building was raised upon the site of some older Romano-Celtic villa.

Safety Envelopes.—In the Journal of the Chemical Society a compound is described for the preparation of what may be called safety envelopes. That part of the envelope covered by the flap is treated with a solution of chromic acid, ammonia, sulphuric acid, sulphate of copper, and fine white paper. The flap itself is coated with a solution of isinglass in acetic acid; and when this is moistened and pressed down on the under part of the envelope, a solid cement is formed, which "is perfectly insoluble in acids or alkalies, in hot or cold water, and in steam."

The Bursting of Firearms.—Professor G. Forbes read a short paper before the British Association on "The Bursting of Firearms when the Muzzle is Closed with Snow, Earth, &c." This well-known fact was explained in a simple manner. If the charge move slowly, of course a very small pressure of air would drive out the obstacle, which offered a very small resistance. But in practice the charge travelled with a speed of more than 1,000 feet a second. The mathematical investigation showed that the pressure, generated with a plug of the density of air, is 7½ tons. This pressure was independent of the size of bore of the gun and of the length of the plug.

Wine from Oranges.—The constantly-extending ravages of the phylloxera have induced the inhabitants of certain wine-growing countries to consider from what

fruit might be obtained a product which by appearance, taste, and bouquet would most resemble the juice of the grape. Experiments have been made, and the fact has been established that the liquid extracted from the orange would constitute a resource on which to fall back. The first trials made showed that the oranges, when they have obtained their full development, are unfit for the purpose proposed, and they must be selected, not when they have become quite mature and superabound in the sugary principle, but before they are wholly ripe, and still possess an appreciable amount of citric and malic acids. At present four different sorts of wine have been obtained from that fruit. One called imperial, and another a dry wine, are procured in January with the fruit of the season; another, the mandarin, is furnished by the orange gathered in April. Those three sorts have a colour pleasing to the eye, are perfectly translucid, have an agreeable savour, with a slight tinge of acidity, and an alcoholic richness of about 15 per cent. As to the fourth, a sparkling wine prepared by a special process; it possesses little more than 12 per cent. of alcohol. However, the experiments made hitherto are still too insufficient, and the methods of fabrication too rudimentary, for the article to be placed upon the market. Besides, another very important question arises, viz., if every success is obtained in the production, can a sufficient quantity of the fruit be procured to replace the grape, and, if so, what will be the relative cost of wine from the vine of the orange? Doubtless, attention once turned in that direction, we shall be provided with some sort of liquor, probably of excellent quality, but we vastly doubt whether the orange or any other fruit can ever compete with the grape.

How to Keep Potatoes.—The following is the French method:—A large kettle or boiler of water being placed over the fire, and its contents raised to boiling point, the potatoes, previously well washed, are placed, a few at a time, in small baskets or nets, which are then thrust rapidly under water and there retained for about four seconds. Of course, the introduction of so considerable a bulk of cold matter lowers the temperature of the water somewhat, and care must be taken that it rises to the boiling-point again after each immersion before a fresh netful of potatoes is introduced. As each batch is withdrawn it must be shaken and spread out on the flooring to dry in some well-aired place. When all the stock has thus been treated and is thoroughly dry, it should be stowed away in some dark room, of course free from damp. The potatoes will be found to have lost all tendency to germination, and will remain sound and well-flavoured till the next year's crop comes in. It is said to be in this manner that Parisian hotel and restaurant keepers preserve their supplies so well for summer use.

The Metric System of Weights and Measures.—From a statistical table recently constructed by M. D. Malarce, and published in *Comptes Rendus*, it appears (1) that the decimal metric system

of weights and measures is now established legally and obligatorily in eighteen States, comprising a population of 236·6 millions of inhabitants (these States are France and colonies, Belgium, Holland and colonies, Germany, Sweden, Norway, Austria-Hungary, Italy, Spain, Portugal, Roumania, Greece, Brazil, Columbia, Ecuador, Peru, Chili, and the Argentine Republic); (2) that it is made legally optional in three States, having a population of 75·6 millions—viz., England, Canada, and the United States; (3) that it is admitted in principle, or partially for customs, in five States, with 343·6 million inhabitants—viz., British India, Russia, Turkey, Venezuela, and Hungary; (4) and that, altogether, the system is established obligatorily, or optionally, or in principle, in 26 States, comprising 655 million inhabitants. Four States have different systems, decimal as to multiples and divisions, but based on another unit than the metre They comprise 471 million inhabitants, and are Switzerland, Mexico, Japan, and China. To these may be added some mediocre States, with various systems, non-decimal and non-metric. It appears, then, that in 1879 more than half the population of civilised States, comprising 1,180 million inhabitants, legally recognize the decimal metre system of weights and measures. A large part of this progress is in these recent years.

The Magic Mirror of Japan.—Professor Ayrton lectured early in 1879 at the Royal Institution, his subject being "The Magic Mirror of Japan." In Japan there is, he said, an absence of house walls, interior and exterior, the houses consisting of a roof supported on only a few posts enclosing very little but empty space, and sliding screens alone divide off compartments. Why, in this comparative absence of all that we should call furniture, does one article pertaining to the ladies' toilette—the bronze mirror with its stand—hold so prominent a position? This mirror is usually circular, from 3 in. to 12 in. in diameter, made of bronze, and with a bronze handle covered with bamboo. The reflecting face in generally more or less convex, polished with a mercury amalgam, and the back is beautifully ornamented with a gracefully-executed raised design. Some for the rustic population have also polished letters.

The explanation of the fact that the mirror is almost *par excellence* the entire furniture, is found partly in the elaborate headdresses of the Japanese ladies, and the painting of their faces, and partly from the belief that as the sword was "the soul of the Samouri," so is the mirror the "soul of woman." It therefore constituted the most valuable of all her possessions, and two mirrors form part of the trousseau of every bride. The characteristic qualities of the mirror must, it is believed, be in accordance with the constitution of the possessor, and "second sight" is resorted to in the selection of a mirror.

But why is the mirror so important in the Imperial palace, where the Court ladies, still preserving the fashion of old days, comb back

their hair in the simplest style? Why does the fortune-teller, instead of looking at a girl's palm, regard the reflection in the mirror? Why, instead of referring to the book of the recording angel, does the Japanese Plato bring before the boatman his evil deeds reflected in a mirror? And why does the mirror hold so important a place in Japanese temples?

The mirror ranks far higher in Japanese history than has been supposed; it, in fact, takes the place of the Cross in Christian countries. Professor Ayrton read the myth of the origin of the worship of the mirror. The main points in it are that when gods alone inhabited the earth the sun-goddess one day hurt her hand with her shuttle, having been suddenly frightened by a practical joke of her brother, the god of the sea. She indignantly retired to a cave. Darkness followed, and the goddess had to be appeased. The wisest of the gods suggested making an image of her more beautiful than herself. The Japanese Vulcan fashioned a mirror in the shape of the sun, and all the gods laughed and shouted, "Here is a deity who surpasses even your glory." Woman's curiosity could not stand this. The goddess peeped out, and while admiring herself in the mirror was caught and dragged out by a rice rope. The national traditions have it that this sun-goddess (Amaterasu ô mi Kami), sending her adopted grandson, who was also the great-grandfather of the first Emperor of Japan, to subdue the world, made him three presents: the *magna-tama* (the precious stone, emblematical of the spirit of woman), the sword (emblematical of the spirit of man), and the mirror (emblem of her own soul). "Look," she said, "on this mirror as my spirit, keep it in the same house and on the same floor with yourself, and worship it as if you were worshipping my actual presence."

A Remarkable Clock.—There is now on exhibition in Detroit, Michigan, a clock (the work of Mr. Felix Meier, a mechanic) which is said to eclipse the famous clock at Strasburg in complexity and interest. It stands 18 feet in height, and is enclosed in a black walnut frame, elaborately carved and ornamented. The crowning figure is that of "Liberty," on a canopy over the head of Washington, who is seated on a marble dome. The canopy is supported by columns on either side. On niches below, at the four corners of the clock, are four human figures representing "Infancy," "Youth," "Manhood," and "Age"; each has a bell in one hand and a hammer in the other. The niches are supported by angels with flaring torches, and over the centre is the figure of Father Time. At the quarter hour, the figure of the infant strikes its tiny bell; at the half-hour, the figure of the youth strikes his bell of louder tone; at the third quarter, the man strikes his bell; and at the full hour the grey-beard. Then the figure of Time steps out and tolls the hour, as two small figures throw open doors in the columns on either side of Washington, and a procession of the Presidents of the United States follows. As the

procession moves, Washington rises and salutes each figure as it passes, and it in turn salutes him. They move through the door on the other side, and it is then closed behind them. The procession moves to the accompaniment of varied music played by the clock itself. The mechanism also gives the correct movement of the planets round the sun, comprising Mercury, which makes the revolution once in 88 days; Venus, in 224 days; Mars, in 686 days; Vesta, in 1,327 days; Juno, in 1,593 days; Ceres, in 1,681 days; Jupiter, in 4,332 days; Saturn, in 29 years; Uranus, in 84 years. As these movements are altogether too slow to be popularly enjoyed, the inventor has added a device by which he can hasten the machinery to show its working to the public. There are dials which show the hour, minute, and second in Detroit, Washington, New York, San Francisco, London, Paris, Berlin, Vienna, St. Petersburg, Constantinople, Cairo, Pekin, and Melbourne. The clock also shows the day of the week and month in Detroit, the month and season of the year, the change of the moon, &c. It is said that Mr. Meier has worked on this clock nearly ten years, and for the last four years has devoted his whole time to it.

The Mythology of Fairy Tales.—Mr. W. R. S. Ralston, M.A., delivered a lecture, early in 1879, in the theatre of the Society of Arts, John Street, Adelphi, on "The Mythology of Fairy Tales." After mentioning a number of popular tales in which reference is made to the subjects most befitting the consideration of a society intended for the encouragement of arts, manufactures, and commerce, the lecturer passed on to the question of the mythological meaning of fairy tales in general. In the case of Cinderella, for instance, he first dwelt upon the dispute which has of late arisen as to the material from which her famous slipper was manufactured, and then proceeded to discuss the probable significance of the history of her fortunes. As to the slipper, it was likely to remain of glass in juvenile belief, in spite of the letters which have recently appeared in the *Times* by "X." and others, pointing out that the *verre* of Perrault's tale was a transformation of the now obsolete French word *vair*, or fur; in spite, also, of the fact that in the scores of versions in the story which have been collected from every country in Europe, a glass slipper is unknown out of France, except in regions where a French influence is perceptible. But just as the quaintness of the idea that Cinderella was shod with glass commended itself to the fancy of the child, so did the brilliance of that material render it acceptable to the reason of the "solar mythologist," who recognized in it a substance which "is perfectly in keeping with a luminous myth." For this reason, the lecturer said, a learned professor of Sanskrit at Florence considered that the legend of the lost slipper and of the marriage to which it leads formed the central interest of the story. But, in reality, the slipper business seemed to be merely introduced for the sake of the final recognition, which had formed

part of the stock-in-trade of the dramatist from the earliest days of the stage. The idea really embodied in the main part of Cinderella's story appeared to be that of the temporary obscuration or eclipse of some brilliant being, and its embodiment probably formed in its earlier periods a true nature myth, though it might be impossible to decide to what phenomena of nature it specially referred, whether to the dawn which follows the darkness, or to the spring which succeeds the winter, or to the fine weather which is ushered in by the storm. But, in addition to this, the story of Cinderella seemed to be fraught with two other inner meanings, corresponding to its two separate openings. One of these openings was the stepmother story, with which we were most familiar, and its leading idea seemed to when we sought for it in complete versions of the tale, that a loving mother might even after death console and assist a dutiful child. The other, the less familiar opening, was that in which the heroine fled from an unlawful marriage, as in the case of the German Allerleirauh or the Norse Katie Woodencloak. Whether the union from which she escapes was a mythological metaphor, or due to a vague remembrance of prehistoric marriage customs, was a question which it would be hard to decide.

The Elements of Psychology.—Professor Huxley, F.R.S., delivered a lecture in the close of 1878 at the London Institution, on "The Elements of Psychology." Starting from the trite observation that man is composed of body and mind, thought and emotion being referable to the latter, while to the former belong form, sensation, and motion, he said that if we follow common experience doubt may often arise as to where the line is rightly to be drawn between what is mental and what is corporeal. There are, however, certain broad and ineffaceable distinctions, and we soon learn, for example, to distinguish between two kinds of pleasure and pain. Nobody would describe a toothache as mental distress, nor would the pleasure derived from eating a good dinner be spoken of as an intellectual one. Though a good concert affects the ear and a fine picture the eye, yet all would agree that they appeal also to the artistic sense of the mind. Language is thus found to be ambiguous, and in order to distinguish clearly between mental and bodily phenomena, they must look closely at the facts.

He would suppose a man to be walking along the highway, and to be thrown into consternation by hearing a pistol suddenly fired. The wayfarer would say he heard a loud sound, started, and felt alarm. A scientific physiologist, whom we may suppose stone-deaf, would give a somewhat different account of the matter. He would speak of the air between the pistol and the man's ear being thrown into a state of vibration; this would affect the mechanism of the ear, causing first a finer sort of vibration to be communicated from the drum of the ear to the auditory nerve, and at length setting up a molecular motion of the muscles, making the hearer start. The tidings passing to the

brain would account for the emotion of alarm. This physiological series of movements was objective, and could be made palpable to well-trained observation. But parallel and contemporaneous with these objective phenomena there were other subjective processes, which we could know in no other way than through the testimony of individuals experiencing them. The scientific investigation of these subjective phenomena was the province of the psychologist, just as physiology and anatomy dealt with the parallel series of objective facts.

Of the strange obscurity thrown around the study of psychology, or the science of mental phenomena, by excessive speculation and complicated hypotheses, he would try to keep clear by sticking to the simple terminology of Hume, who proposed to call all the phenomena of consciousness "perceptions" or "states of mind." These Hume subdivided into the original impressions made upon the senses and the reproduction of such first-hand or fresh impressions through the faculty of memory. Professor Huxley would not discuss whether Hume's account of mental phenomena was an exact or exhaustive one. But there could be no doubt as to what that philosopher meant by the terms he employed, and in this respect he had a great advantage over more modern psychologists.

It was clear that some account must now be taken of the muscular sense, in addition to the five known to the ancients, and Professor Huxley was himself prepared to add relational perceptions to the two subdivisions proposed by Hume. Perceptions of relation ----- from the co-existence of sensations. For example, from the co-existence of certain sounds arose the perception of harmony, and the pleasure thus caused. So there was a harmony of colour appealing to the sense of sight. We could even speak of a harmony and melody of the palate, with which the culinary art had to deal. Besides the co-existence of sensations, relational perceptions comprehended their succession, and their likeness or unlikeness.

Professor Huxley was disposed to think that the primary perceptions or states of consciousness caused by first-hand sensation, might very likely be the only ones known to beings in the earliest stages of animated life. But higher up in the scale there was a power of reproducing sensations, which might be termed ideation. How many ideas, for instance, were suggested by the word "rose?" He himself was wont to recall the flower's form, colour, and even the pricking of his finger by the thorn. They would be astonished on trying the experiment to find how many things might be suggested by the word which symbolizes the rose. The name called up the thing, and the thing the name, by a magic law of association which, however difficult to explain, none the less gave a true statement of the facts.

Professor Huxley then discussed the theory of our beliefs as to both past and future events—*i.e.*, our remembrances and our expectations. It was declared to be a fundamental and principal law of psychology that all beliefs as

to the past must rest on experience. So, too, with our belief of expectation, as when a burnt child dreads the fire. The lecture concluded with a comprehensive survey of the border-land connecting physiology and psychology. He rejected the Cartesian hypothesis which interpolated between the objective and subjective phenomena an immaterial something without form, shape, or dimensions. So, too, he could see no good reason for adopting Leibnitz's hypothesis of concurrence between the two series, as between two clocks set by an external power to keep the same time. He thought that as a working hypothesis at least, the materialistic was the best, although he by no means affirmed that it was free from serious difficulties of its own.

Island of Tristan d'Acunha.—This island in the South Atlantic, which is rarely touched at by vessels, has been visited by the Government vessel *Emerald*, on her way to Western Australia. The little colony, consisting of the Governor, Peter Grant, and his ninety subjects, were well, and delighted to greet their visitors, and a supply of books and newspapers, but they were less enthusiastic at the present of a score of cats which the Government had sent out, hearing that the island was impoverished by swarms of mice. It appears that cats are as plentiful as mice in Tristan d'Acunha, and while the mice destroy every green blade on the island, the cats live on friendly terms with their hereditary enemies, and scorn to eat them, preferring to catch chickens and young sea-birds. The inhabitants are accordingly obliged to trap the cats by hundreds.

On the Early History of Cyprus.—In a recent communication to the Royal Geographical Society, Sir Henry Rawlinson explained his views on some points in the early history of Cyprus. Among the earliest colonists of the island he places the Kittam (Chittam) and Dodanim of Scripture, both being of Syrian race; and he believes that the expression in Balaam's prophecy, "And ships shall come from Chittim," refers to Cyprus. This goes a long way back, for the date usually assigned to that prophecy is the fifteenth century B.C. The second colonisation is supposed to have been Phœnician, and the third Cypriote; "that is, of the people who introduced the alphabet and language known to us by the Cypriote inscriptions, and who founded that school of art to which belong most of the statues and sculptures that have been excavated from the ruins of cities and temples in varions parts of the island." They probably came from the western part of Asia Minor. And lastly, the fourth colonisation was that of the Greeks proper, about the eighth century B.C. But more than this. There is reason to believe that the elder Sargon, a king of Babylonia, seventeen centuries B.C., after over-running Syria, crossed the Mediterranean to Cyprus, where subsequently his son Naramsin was deified, and where a thousand years later the second Sargon set up an image of himself, as is recorded on a monolith found at Larnaca,

the ancient Citium. A century later, as is proved by the cuneiform inscriptions, ten kings of Cyprus who were tributary to Assyria, sent artificers to assist in decorating the temples and palaces of Nineveh. In Amta Khadasta, the residence of one of those kings, Sir Henry Rawlinson finds the Assyrian origin of the name of a city about which there has been of late some discussion. The Greeks abbreviated it to Ammochosta, and the Cypriotes transmuted it into Famagousta, which "has nothing whatever to do with Fama Augusti, as has been sometimes supposed."

Savings and Savings-Banks.—Professor Leone Levi had prepared a most interesting paper on "The Savings of the People as evidenced by the Returns of Trustees of Post Office Savings-Banks." He remarks that in his last report to Mr. Bass, M.P., on the earnings of the labouring classes, including labourers and artisans, (*see* p 160) he estimated their total amount in 1878 at about £422,000,000, of which £350,000,000 was in cash, and £72,000,000 in board, lodging, clothing, and other requisites. The wages were somewhat higher in 1878 than in 1866, though considerably lower than in 1872 and 1873, yet the total amount of earnings was not greater, in consequence of the stagnation in trade, which reduced the number of labourers at work and the number of days when they were actually earning wages.

The difference in wages to the working men of the United Kingdom between prosperous and bad times was £50,000,000 a year, and it was interesting to ascertain how far the labouring classes had to learn to set something aside for a rainy day. In the three years from 1871 to 1873, when wages rose at least 20 per cent., and in some cases 40 and 50 per cent., the labouring classes received in hard cash some £70,000,000 per year, or a total of £210,000,000 in three years more than the normal amount. The cost of living during those three years increased, however. A rise of wages was not all gain to the working man, for the cost of production increased, and higher prices had to be paid for food, rent, and every enjoyment. That rise he estimated at 10 per cent., therefore £105,000,000 was required for the increased cost of living in the three years. Allowing 5 per cent. more for a legitimate increase of the comforts of life in times of prosperity, or £42,500,000 in the three years, in all £147,500,000, there still remained £63,000,000 which should have been saved and stand now to the credit of the labouring classes in some form or other.

Since 1873 wages had suffered a considerable fall, yet even now in many occupations the wages were liberal, and with the lower prices of many articles of daily consumption there might be room for saving something if only a sense of economy and proper management prevailed in the households of the working population. For at least the half of the last eight years wages were most liberal, and afforded ample room for saving a handsome amount.

What trace of these savings did they find stored in the saving-banks? The accounts of the savings-banks in 1870 and 1878 stood as follows:—In 1870 trustees' savings-banks, £37,958,000; post-office savings-banks, £15,099,000; total, £52,987,000. In 1878, trustees' savings-banks, £44,293,000; and post-office savings-banks, £30,412,000; total, £74,705,000. Thus, the savings-banks in 1878 possessed £21,700,000 more than in 1870. Deducting £14,000,000 for interest during those eight years, there remained £7,500,000 saved in this form out of all the extra wages in the eight years. It could not be said that what was saved in 1873 had been since lost and withdrawn, for the accounts showed that in the total there had been no going back, but only a slow progress, as shown by the following table:—

	England & Wales.	Scotland.	Ireland
1870	£46,229,000	£4,132,000	£2,636,000
1878	£64,433,000	£6,726,000	£3,546,000

This was an increase of 24 per cent. for England and Wales, 50 per cent. for Scotland, and 32 per cent. for Ireland. The results of the last eight years were, therefore, the most favourable to Scotland and Ireland next to England and Wales. Comparing six agricultural with six manufacturing districts, he found that the savings of the manufacturing districts had increased 48 per cent., and the agricultural 71 per cent.; but he affirmed that in large towns there were many other ways of saving, and that might account for the difference in the per centage. He advocated a closer connection between savings-banks, workshops, and schools, so that the idea of saving might be ever before the population.

Indian Pottery.—Dr. George Birdwood read in the close of February, 1879, at the Society of Arts, a paper on Indian Pottery. Premising that at the Exhibition held last year in Paris the pottery received from India particularly excited the admiration of the more cultivated visitors, Dr. Birdwood said he wished to draw attention to the influences which are enfeebling and corrupting its artistic character, and which will only become aggravated by the commercial demand now sure to spring up for it, unless they are from the first intelligently resisted alike by its purchasers, importers, and manufacturers. The principal varieties of Indian pottery suitable for exportation are the red earthenware pottery of Travancore and Hyderabad, the red glazed pottery of Dinapoor, the black and silvern pottery of Azimghur and Surat, the painted pottery of Kotah, the gilt pottery of Amroha, the glazed and unglazed pierced pottery of Madura, and the glazed pottery of Scinde and the Punjab. In all these varieties of Indian fancy pottery an artistic effect is consciously sought to be produced; but only the pottery made at Azimghur, and in Scinde and the Punjab, and the Bombay School of Art pottery were exhibited at Paris, and it is only of these examples that Dr. Birdwood spoke.

The Azimghur pottery, like most of the art work of the Benares district and eastward, is generally feeble and rickety in form, and insipid and meretricious in decoration—defects to which its fine black colour gives the

greater prominence. The silvery ornamentation is done by etching the pattern, after baking, on the surface, and rubbing an amalgam of mercury and tin into it. The charms of the glazed pottery of Scinde and the Punjab are the simplicity of its shapes, the spontaneity, directness, and propriety of its ornamentation, and the beauty of its colouring. The first thing to be desired in pottery is beauty of form. But, for household use, pottery must generally be glazed, and neither glazing nor colouring need detract from its dignity or comeliness, while they often enhance the delicacy of surface required for the complete exposition of its gracefulness of configuration. If any ornamentation is applied, it must be skilfully subordinated to the form to which it is superadded, so as not in any way to divert attention from it. Nothing can be in worse taste, nor, in an æsthetic sense, more wasteful than to hide a lovely form under an excess of foreign ornament. In Indian pottery we always find the reverent subjection of colour and ornamentation to form, and it is in attaining this result that the Indian potter has shown the true artistic feeling and skill of all Indian art manufacturers in his handiwork. The correlation of his forms, colours, and details of ornamentation is perfect, as if his work were rather a creation of nature; and this is recognised, even in the most homely objects, as the highest achievement of art.

The great secret of his mastery is the almost intuitive habit of the natives of India of representing natural objects in decoration in a strictly conventional manner—that is to say, symmetrically, and without shadows. He maintains inviolate the integrity of form and harmony of colouring, and the perfect unity of purpose and homogeneity of effect of all his work. The mystery of his consummate work is a dead tradition now; he understands only the application of its processes; but not the less must it have been inspired in its origin by the subtlest interpretation of nature. The potter's art is of the highest antiquity in India, and the unglazed water vessels made in every Hindoo village are still thrown from the wheel in the same antique forms represented on the ancient Buddhistic sculptures and paintings. Some of this primitive pottery is identical in character with the vases found in the tombs of Etruria, dating from about 1000 B.C. The glazed pottery of Scinde is made principally at Hala, and that of the Punjab at Lahore, Mooltan, Jang, Delhi, and elsewhere. It dates from the thirteenth century, and was directly influenced by the traditions surviving in Persia of the ancient civilisations of Nineveh and Babylon. It is found in the shape of dishes, plates, and water-bottles, jars, bowls, and pots of all shapes and sizes, also of tiles, finials for the tops of domes, pierced windows, and other architectural accessories. In form, the bowls and jars and vases may be classified as egg-shaped, turban, melon, and onion-shaped, in the latter the point rising and widening out gracefully into the neck of the vase.

Dr. Birdwood dwelt at some

length on the preparations required for the glazing and colouring — namely, *kanch*, literally glass, and *sikka*, oxides of lead. In the Punjab the two kinds of *kanch* used are distinguished as *Angrezi kanchi*, "English glaze," and *desi-kanchi*, "country glaze." The ornamental designs are painted on offhand, or a pattern is pricked out on paper, which is laid on the vessel and dusted with powdered colour along the prickings, thus giving a dotted outline of the design, which enables the potter to paint it in with all the greater freedom and dash. It is the plucky drawing and impulsive free-handed painting of this pottery which are among its attractions.

The Indian potter's wheel is of the simplest and rudest kind. It is a horizontal fly-wheel two or three feet in diameter, loaded heavily with clay along the rim, and put in motion by the hand, and, once set spinning, it revolves for five or seven minutes with a perfectly steady and true motion. In the Deccan the potter's field is just outside the village. Altogether he earns between £10 and £12 a year. He enjoys besides the dignity of certain ceremonial and honorific offices. He bangs the big drum and chants the hymns in honour of Jamee, an incarnation of the great goddess Bhowanee, at marriages; and at the *dowra*, or village harvest-home festivals, he prepares the *burbut*, or mutton stew. He is, in truth, one of the most useful and respected members of the community, and in the happy theocratic organisation of Hindoo village life there is no man happier than the hereditary potter, or *koombar*. We cannot overlook this serenity and dignity of their lives if we would rightly understand the Indian handicraftsman's work. He knows nothing of the desperate struggle for existence which oppresses the life and crushes the very soul out of the English working man. The sun is his landlord and coal merchant, upholsterer, tailor, publican, and butcher — the co-operative store from which he gets almost everything he wants, and free of all cost in coin. This at once relieves him from an incalculable dead weight of cares, and enables him to give to his work, which is also a religious function, that contentment of mind and leisure and pride and pleasure in it for its own sake which are essential to all artistic excellence.

The Indian *ryotwaree* tenure, or system of peasant proprietorship, is first and most simply described in the Bible in the xlvii. chapter of Genesis. Joseph was really the astute and far-sighted author of one of the greatest and most successful agrarian revolutions on record, beside which the revenue reforms of Todar Mal under Akbar, and the "Cornwallis (Permanent) Settlement" of 1793, and the revenue survey of the North-West Provinces, by Robert Bird, in 1824, shrink into insignificance. The system of peasant proprietorship may possibly contribute indirectly to retard the advancement of a country, even where it does not conduce directly to the petrifaction of its civilisation, as in India. Under it the Hindoo ryot has become so strongly attached by the most

sacred and deeply-rooted ties to the soil, that rather than relinquish his hold on it he will burden himself and his heirs with debt for generations ; and gradually, under the Hindoo practice of inheritance, the holdings become so minutely subdivided and overburdened by mortgages that extended cultivation and high farming are made almost impossible. It is a notable fact that while machinery should have been so readily applied in India to the production of textile and other manufactures, in which its use is injurious, its introduction in agricultural operations, in which it would so incalculably benefit the people, has been found impossible. It is quite impossible under the land system of the country at present. Dr. Birdwood remembers a steam plough being introduced with great *éclat* into the Bombay Presidency It was led in procession into the field, wreathed in roses, and all who went to see it were wreathed with roses and sprinkled with *attar*. But it was found impossible utterly to make any use of it. It was introduced into a fixed crystallised sacro-economic system, in which it had no place, unless as a new divinity, and a new divinity and an idol it was made. It was put away into the village temple, and there, after a time, its great steel share was bedaubed red, and worshipped as a god.

As a mere question of accounts there can be no doubt of the solvency of India, but owing to the restricted and imperfect cultivation of its soil, it is incapable of supporting the great cost of good government in modern times with the elasticity and buoyancy which would at once result from the proper development of its really inexhaustible agricultural resources. The country grows rich too slowly, and the demands of a scientific government increase on it too rapidly, and the reason of it undoubtedly consists in the Indian form of peasant proprietorship. Then again, under this system, as it has been elaborated in India, there is a great loss personal and national energy. The whole community is provided for ; every man in it has his ordered place and provision. There is no stimulus to individual exertion, and the mass of the people are only too well contented to go on for never in the same old-fashioned and conservative ways as their fathers from time immemorial before them. But to the *ryotwaree* tenure we owe all the primitive arts of India, and when it becomes disorganized and perishes, they too will sink and pass away for ever. It created the conditions of society, so picturesque in its outward aspects, so simple and fascinating in its inner life, in which the arts of India originated, and on the permanence of which their preservation depends. The art of the glazed pottery of Scinde and the Punjab is probably not older than the time of Chingiz Khan. In all the Imperial Mogol cities of India where it is practised, especially in Lahore and Delhi, the tradition is that it was introduced from China, through Persia, by the Mongols, through the influence of Tamerlane's Chinese wife, and it is stated by independent European authorities that

the commencement of ornamenting the walls of mosques with coloured tiles in India is contemporary with the Mongol conquest of Persia. But in Persia the ancient art of glazing earthenware had come down in an almost unbroken tradition from the period of the greatness of Chaldea and Assyria, and the name *kasi*, by which the art is known in Persia and India, is the same Semitic word *kas*, glass, by which it is known in Arabic and Hebrew, and carries us back direct to the manufacture of glass and enamels for which "great Zidon" was already famous, 1,500 B.C.

The designs used for the decoration of this glazed pottery in Scinde and the Punjab also go to prove how much it has been influenced by Persian examples, and the Persian tradition of the ancient art of Nineveh and Babylon. The "Knop and Flower" pattern, which we all know in Greek art as the "Honeysuckle and Palmette" pattern, appears in infinite variations on everything. The Bombay School of Art pottery we owe chiefly to the exertions of Mr. Terry, the superintendent of the School. He has introduced potters from Scinde, but as yet Dr. Birdwood has never seen any pottery from the School in imitation of that made in Scinde and the Punjab, which is quite satisfactory; while that produced by the students of the School who have set up as potters on their own account in Bombay, in imitation of the Scinde pottery, is simply detestable. The scientific investigation of Indian art will not fail to lead to profitable, and perhaps, even surprising results. But, personally, Dr. Birdwood views the matter from quite another point. Nothing conduces more than such studies, and the conclusions to which we now see they almost invariably lead, to free men from all jealousies of race and international prejudices, and all narrow provincial and insular ideas. Europe and Asia are one continent, and the English and Hindoos one family, united by a common origin, language, and history, and the more widely this is seen and felt the more will they become united by a common sympathy in all the higher, nobler aims of life.

Wild Animals in Algeria.—Wild animals are rapidly disappearing from Algeria. The French Government pays up to £2 for every lion or panther that is killed, and about 1s. 6*d.* for every jackal. In 1877 rewards were paid on 53 lions, 49 lionesses, 9 cubs; 530 panthers, 45 young panthers; 1,072 hyænas; and 14,784 jackals. Lions and panthers abound most in the wooded province of Constantine, hyænas are most numerous in that of Oran, jackals in that of Algiers.

A Post-Card on its Travels.—A journey round the world has lately been made by a humble post-card, which completed the trip in ninety days and twenty hours. Six post-cards and six letters were sent off by the *Paper and Printing Trades' Journal* as a test of the care bestowed by postal authorities on post-cards *versus* letters. The faces of the dozen travellers were ruled into six compartments for the various addresses and stamps, and on

the backs were printed instructions to the recipients as to their being forwarded, while spaces were left for the date of receipt. Posted in London on October 1st, 1878, they reached Alexandria on the 9th, and Singapore on November 4th, and being sent off the same day came to grief between Singapore and Yokohama, only one post-card and five letters appearing at Yokohama on November 24th. Starting again next day on their travels, the card and letters arrived at San Francisco on December 12th, at New York on the 21st, and got home to London in safety by the first post on December 31st. The blame of the loss does not rest with the British postal system, but with the authorities between Singapore and Yokohama.

Sir William Fairbairn, Bart., F.R.S.—The frontispiece of the current volume of the "Year Book of Facts," represents a statue placed in Manchester Town Hall within the last few months in memory of this eminent mechanical engineer. Sir William Fairbairn, who died about five years ago, was highly esteemed in Manchester, and throughout the manufacturing district of Lancashire and the West Riding, as well for his personal character as for his valuable scientific and practical achievements, which contributed to augment the industrial wealth of a busy community. The statue is of marble, 7 ft. high; and the sculptor, Mr. Edward Geflowski, of Bruton Street, has succeeded admirably well in representing the face, figure, and habitual attitude of Sir William Fairbairn, with his characteristic air of intent and profound meditation. Sir William, who was a native of Kelso, on the Tweed, and was born in 1789, was one of the first mechanicians to employ iron as the material of ship-building, and in the construction of bridges. He studied the properties and uses of that metal, especially its strength in resisting tension, with the greatest assiduity through a prolonged series of experimental researches and exact calculations. To the improvement and greater safety of steam-boilers, used in the manufacturing districts, his labours contributed in no slight degree He was one of the founders of the British Association for the advancement of Science, and a President of that Association, a Fellow of the Royal Society, and author of several treatises upon the iron manufacture, engineering, and other subjects. He was created a Baronet in 1869, which title is now borne by Sir Thomas Fairbairn, his eldest son, a Commissioner of the Great Exhibition in 1851 and 1862.

Natural Daylight for Dark Rooms.—Not a few in every large community have to endure the discomfort, and ill health arising from dimly-lighted apartments. The daylight may be obstructed and impeded owing to the bad construction of buildings, or the small dimensions of windows, or the proximity of opposite walls, or some other local cause. At all events, the rooms are dark and the occupants are sure to suffer ere long, even though gifted with the strongest constitutions. To light the gas, as a way out of the difficulty, is but to pass from one danger to another, for to sit all

day working by gaslight is about as injurious to the lungs as carrying on one's occupation by a faint light is to the eyesight.

The only remedy we have met with that really answers all the requirements of the case lies in the patent reflectors of Mr. P. E. Chappuis. These will be found uncommonly useful in all buildings the light of which is in any way defective. They can be easily adapted where there is either grating, area-window or skylight, and will be found to effect a considerable saving in the cost of gas, and greatly to conduce to health and comfort. "Chappuis' Patent Reflectors" are also used as screens or blinds, whilst, at the same time, they act as daylight diffusers.

Artificial Teeth Improved.—There are few lines of scientific industry in which a greater advance has been made of late years than in the manufacture of artificial teeth. And no one has contributed more to progress in this department than Mr. G. H. Jones, of Great Russell Street, one of whose most recent improvements is the application of the principle of the common sucker to the artificial palate. Mr. Jones's patent suction-valve is an ingenious contrivance of great simplicity, by which the upper case of teeth is kept firmly in the mouth, and can only be removed at the will of the wearer. The action is simple, while the effect is most perfect. The tongue easily, and by a natural movement, effectually exhausts the air from the valve, and the teeth are retained *in situ*, upon the principle by which a boy raises a stone by means of an ordinary sucker. This plan obviates the old and somewhat clumsy arrangement of fitting teeth with springs and wires, which frequently require repair, while the perfect contact of the artificial teeth with the roof of the mouth, which this improvement secures, prevents crumbs and portions of masticated food from hanging about the mouth—always a source of discomfort, and tending to produce a foulness in the breath, not only inconvenient to the patient, but which is always a sure indication of the presence of ill-fitting artificial teeth. The improvement thus explained possesses the very important recommendation of rendering the secure fixing of artificial teeth a painless and easy operation. All the inconveniences which patients suffer under other less simple and effective methods are entirely avoided, and the artificial teeth are so firmly held in their place that the power of mastication and articulation is not in the slightest degree impaired.

The Prickly Comfrey.—This plant having been recently spoken of as a sham, as a delusion, and a snare, by certain correspondents of the agricultural journals, it is satisfactory to have the opinion of a practical farmer and experimentalist who, writing to an agricultural contemporary, records a yield in the first year (1875) of growth of 6 lb. per plant, in the next year of 10 lb., in 1877 of 10 lb., in 1878 of 5 lb., 1879 of nearly 10 lb. This writer remarks, "The horses have had it cut up with hay into chaff, and the cattle eat it out of cribs just as it is cut. Sheep and pigs, too, are very fond of it after they get accustomed to it. The

severe frosts of the present year have been borne very well." We have been informed from other sources that it is a moisture-loving plant, and that even if its good qualities have sometimes been exaggerated, it certainly is an excellent thing for odd corners of land in which most English crops will not thrive.

Names of Places.—The names of the cities, towns, and villages of the United States reveal great poverty of invention. A town's title, to have any real appropriateness, should have a local application, if possible; or, if this is not practicable, a name which perpetuates some incident connected with the early history of the region is a good substitute. A termination in too common use is the French *ville*. Nothing more poor and mean in nomenclature can be found in the gazetteers than this everlasting *ville*. The points of the compass more naturally take a lead in distinguishing an offshoot from an old town. Massachusetts has suspended on the points of the compass more than 200 of her towns. There are in the whole country no less than 650 towns and cities which have *west* for a prefix. There are more than 600 *norths* of various combinations, Northfield coming out strong in the list. In North Carolina, where the word south is very dear, one community, as if in despair of finding a title not already in use, have called their town South Toe. There ought to be a North Toe, or, at least, a Toeville, but there is not. In North Carolina there is a town called Why Not? and there is another in Mississippi. Before Americans took to the points of the compass they had exhausted the word "New." There are 625 towns in the United States bearing that prefix, many of these being in affectionate remembrance of English ancestral homes. Among the odd names, Pennsylvania gives us the novelty of congruity, and Virginia furnishes the euphonious title of Nance's Shop, in the county known by the singular name of Charles City. In Perry County, Kentucky, we find the nice name of Cut Shins, and North Carolina gives the town of Democrat. Appropriately enough, it is in Buncombe County that we find this charming name. North Carolina, which has a monopoly of odd names, is proud to own the post-office of Mutual Love. In Sampson County, same State, is situated the cheerful community of Dismal. Some settlers, in Smith County, Tennessee, confessed their trials in searching for an appropriate name for their place by calling it Difficult. Georgia has a Dirt Town, and North Carolina rejoices in a Tar Heel. In the wilderness of foolish and unmeaning names of our towns we find eight Alphas, and we conclude by noting that there are precisely the same number of Omegas.—*New York Times.*

On Natality in France and Germany. In a recent interesting paper on this subject, M. Bertillon comments on the fact that all the efforts of the French agricultural population, the thrifty *bourgeoisie*, is applied to forming and amassing capital. Germany, on the other hand, seems to have

more aptitude for producing men, a race of warriors "apt to seize with strong hand a capital already formed." The German Empire counts at present more than 40 million inhabitants, and has a general natality of 40 per annum and per 1,000, giving annually 1,600,000 live births. But if she were limited to the French small natality of 26 instead of 40, she would count only 1,040,000 live births annually. Thus, compared with France, Germany rears an annual excess of 560,000 children over what French natality would give, and this excess produces annually, according to tables of mortality, about 343,500 adults of 20 years of age. But, on the other hand, if we take as base what a man costs to bring up, it appears from various calculations that we must estimate at not less than 4,000f. the value of an adult of 20 years of age. Then 4,000f. + 343,500 = 1,376,000,000f. This is the annual sum which the excess of German natality over the French costs. A like calculation made for France shows that she would have to expend annually 1,240,000,000f. to bring up the 500,000 infants that are wanting to equal the German natality, which would become 310,000 young people of 20 years of age. Thus France capitalises a milliard and a quarter to the detriment of its posterity, and Germany pays more than a milliard and a third for its own multiplication.

Phosphorescent Clock-dials.—An American clock company has been manufacturing clocks with self-illuminating faces, and they have been on exhibition in the windows of several New York stores. These dials are usually made of paper or thin cardboard, enamelled like visiting cards; they are covered with adhesive varnish, or with white wax mixed with a little turpentine, upon which is dusted with a fine sieve powdered sulphide of barium—a salt which retains its phosphorescence for some little time. The sulphides of strontium and calcium possess the same property, but lose it more quickly than the former. After the dial has remained in darkness some days it loses its phosphorescence; but this may be readily restored by exposure of an hour to sunlight, or, better still, by burning near the dial a few inches of magnesium wire, which gives forth numerous chemical rays.

Modern Progress in Science.—Sir Joseph Hooker on relinquishing the presidency of the Royal Society, to which he was elected five years ago, delivered an address on St. Andrew's Day, 1879, taking for his subject a retrospect of the progress in various branches of science during the last five years. Sir Joseph said that during this time he recognized advances in scientific discovery and research at home and abroad far greater than any previous semi-decade could show. This estimate was explained as not referring to such inventions as the telephone, phonograph, and microphone, nor even to those outcomings of great research and high attainments—the harmonic analyser of Sir W. Thomson, the radiometer and otheoscope of Crookes, or the bathometer and gravitation meter of Siemens—but to those dis-

coveries and advances which appeal to the seeker of knowledge for its own sake, whether as developing principles, suggesting new fields of research, or awakening attention to hitherto unseen, or unrecognised, or unexplained phenomena of nature.

In the foremost rank as regards the magnitude of the undertakings and the combinations of means to carry them out was mentioned the Transit of Venus Expedition, with which, Sir Joseph held, nothing in the history of physical science could compare. The value, he said, of the solar parallax could not be ascertained until the results of all the expeditions were taken into account, when it would have an international claim to acceptance; but he had received a communication from the Astronomer-Royal which stated that the range appeared to be between 92,044,000 and 92,770,000 miles.

After a reference to Janseen's photographs of the sun and Lockyer's discovery of carbon and oxygen in the sun, and his announced observations (to which we have referred elsewhere) on the spectroscope studies which have led him to believe in the indication of the breaking up of the molecules of bodies hitherto regarded as elementary, there were noticed in succession the investigations of electrical discharges by Muller, De la Rue, and Spottiswoode, and Tyndall's experiments on the acoustic properties of the atmosphere.

The essay of Count Gaston de Saporta, on L'Ancienne Végétation Polaire, was then referred to at some length, attention being especially drawn to the way in which the Count suggests a solution of the difficulty which has always presented itself—how to account for sufficient light within the Arctic regions for the rich flora which from fossil evidence it is known formerly flourished there. Saporta takes his facts from the works of Heer, though he differs from him in his inferences. Buffon, in his "Epoques de la Nature," had argued that the cooling of the globe having been a gradual process, the Polar regions must have been the first in which the heat was sufficiently moderate for life to have appeared upon it. Starting from this thesis, Saporta assumes that the termination of the azoic period coincided with a cooling of the water to the point at which the coagulation of albumen does not occur, and that then organic life appeared, not in contact with the atmosphere, but in the water itself. Not only does he regard life as originating, if not at the North Pole, at least near to it, but he holds that for a long period life was active and reproductive only there. Passing from speculations regarding the initial conditions of terrestrial life, the question, the president said, presented itself with regard to the carboniferous and later floras, how could plants have flourished in such latitudes if summers were of months and winters of similar lengths as now? Saporta suggested that besides the effects of probable fogs due to southerly warm oceanic currents, the solar light was, perhaps, not distributed over the globe as it now is, but was far more diffusive, the solar body not having arrived at its

present state of condensation. Sir Joseph pointed out that some of Saporta's conclusions were supported by the work of Mr. Thistleton Dyer, who, by a totally different line of research, had arrived at the conclusion that the northern hemisphere had always played the most important part in the evolution and distribution of new vegetable types, or, in other words, that a greater number of plants had migrated from north to south than in the reversed direction, and that all the great assemblages of plants which we called flora seemed to admit of being traced back at some time in their history to the northern hemisphere.

Turning to microscopical botany, a historical sketch was given of the origin and progress of the study of cells and cell divisions. Mr. Darwin's work in physiological botany was epitomised, and in the progress made in morphological botany especial reference was made to the work of Cohn, of Koch, and of Klein, on the development of spores within the rods of Bacillus. A practical result of these observations is that Klein has shown that typhoid fever of the pig is like splenic fever, due to a Bacillus, and it is now distinctly proved that two diseases of the higher animals are generated by *contagium vivum*.

A Powerful Spectroscope.—In the young science of spectroscopy, as in others, an important element of progress is the improvement of instruments for dealing with the phenomena presented, and many minds are engaged on this. A new spectroscope of remarkable power has just been brought to the notice of the French Academy by M. Thollon. Its chief feature is the use of sulphide of carbon prisms, which are closed laterally, not by plates with parallel faces, but by prisms of the form of Amici's—*i.e.*, having curved sides meeting at an angle (which, however, is much smaller than Amici's prism.) The refringent angles of these prisms are in an opposite direction to that of the sulphide prism. Two of these compound prisms are substituted by M. Thollon for the simple prisms in a spectroscope, which he formerly described to the Academy. Without going into further details, we may simply state that an enormous dispersion is obtained; with a magnifying power of 15 to 20 times, the spectrum has a length of 15 metres. The angular distance of the D lines of sodium is about 12′, whereas that produced by M. Gassiot was only 3′ 6″. This instrument should throw considerable light on the structure of the spectrum, and M. Thollon has already noticed some interesting facts. The lines of sodium and magnesium present a dark nucleus passing into a nebulosity, which becomes gradually merged in the continuous spectrum. Many lines have been split up, and all that have been thus resolved have been found to belong to two different substances. One of the hydrogen lines present a nebulosity without a nucleus. M. Thollon remarks on the magnificence of the spectrum of carbon from the electric arc, observed with the new instrument. The spectra of iron, copper, and magnetism in the same arc were also

seen with admirable clearness and brilliancy. These new spectroscopes have been constructed for M. Thollon by the able optician M. Laurent.

Artificial Manures.—Professor G. Ville of Paris has published a book on Artificial Manures and their application to agriculture, which has been translated into English by Mr. Crookes, F.R.S. In it he discusses theory and practice, the composition, growth, nutrition, and cultivation of plants, the assimilation of carbon, oxygen, hydrogen, and nitrogen, the function of mineral matter in plant production, the comparative cost of farm-yard and chemical manure, the importance of the waste parts of crops as fertilisers, and other topics, including tables for calculating the exhaustion of the soil and regulating the feeding of live-stock. In the chapter headed "Agricultural Industry," Professor Ville shows how to cultivate beet-root and carry on a distillery at a profit. "To consume beet-root," he says, "to export alcohol, and to provide pulp for live-stock, a distillery is equal to an increase of meadow land, since it procures an increase of food for the animals. On the other hand, the industrial product that we export is alcohol, and this exportation will not in any way lessen the fertility of the soil. Rain water and the carbonic acid contained in the air cover all the cost, and provide all the raw material; for alcohol contains nothing but carbon, hydrogen, and oxygen. Practical farming confirms the fact that distilleries contribute to the amelioration of the soil, and science explains why."

Professor Ville thinks that English farmers should manufacture chemical manures for themselves, instead of paying unreasonably high prices, as at present. He gives an example: a certain manure, largely used, is sold at twelve shillings the hundred-weight. It contains phosphoric acid soluble and insoluble, and nitrogen in the form of ammonic sulphate, the cost of which amounts to six shillings and four-pence-halfpenny. And besides the saving in expense, there is the certainty that the article is genuine. "Calcic superphosphate," says Professor Ville, "is rather more difficult to manufacture, on account of the necessity of procuring the sulphuric acid. But when a co-operative association has secured the services of a practical chemist, this difficulty vanishes, and the result is well worth the trouble. The farmer will for twopence three-farthings per pound obtain a soluble phosphoric acid, for which manufacturers have been charging him about sixpence."

Savage and Civilised Nations.—At the meeting of the Anthropological Institute early in 1879, a paper by professor Daniel Wilson, of Toronto, was read on "Some American Illustrations of the Evolution of New Varieties of Men," in which the author controverted the prevalent opinion that the contact with more civilised races is necessarily fatal to savage tribes, and brought forward many facts in support of his position. He owned, however, that it is only by the gradual adoption of the usages of civilsation, and by amalgamation with

more progressive peoples, that inferior varieties of mankind can escape the extinction to which they seem doomed. Of this process of blending between the two and the consequent evolution of new varieties of men, he adduced numerous instances.

In concluding his paper Professor Wilson cited the following curious and striking testimony, in proof of the fact that traces of mixed Indian blood are especially common in the province of Quebec: —"I do not think that people generally realise the great extent to which there is an infusion of Indian blood in the French Canadian population. In the Neighbourhood of Quebec, in the Ottawa valley, and to a great extent about Montreal, I hardly think among the original settlers there is a family in the lower ranks, and not many in the higher, who have not some trace of Indian blood. At Ottawa, where we have a large French population, I hardly meet a man—and the women show the traces even more readily—where I should not say, from the personal appearance, that there is a dash of the red man."

Professor Wilson added that in the new province of Manitoba the original population is a half-breed one; and it has begun its political existence with a population numbering from 10,000 to 12,000; a race of civilised hunters and farmers, the offspring of red and white parentage. This is in addition to the much larger number of children of mixed blood, who, following the fortunes of their Indian mothers, grow up members of the nomad hunter tribes. There, more than elsewhere, he sees an analogy to that which may be assumed to have produced the Melanochroi of Europe's prehistoric ages, when the intruding Aryan first came into contact with Turanian or Allophylian tribes of that Neolithic period when the arts of the metallurgist were there already—as they are now in the unsettled territories of the New World—beginning to supersede the ingenious processes of a purely stone and bone, or of a native copper period.

Railway Carriages for Sightseers.—Since the leisurely days of stage coaches, much of the poetry of travelling has departed. The rate at which trains rush through lovely scenery allows but scant opportunity for appreciating it; and, indeed, unless a corner seat be secured, there is little to be seen at all. Some of the Continental railway companies have tried carriages better adapted for viewing scenery than the ordinary. In a recent number of the *Organ Fur Fortschritte*, &c., is an account, with drawings, of a type of carriages introduced on the Rhein-Nahe Railway with this view. There is a sort of spacious verandah at one end outside the inclosed part, and one can walk freely throughout the carriage. In winter some simple alterations are made to adapt the carriage for use then; partitions are put in, the verandah enclosed, &c.

South African Folk Lore.—*Nature* draws attention to a society recently formed at Cape Town for the collection of South African folk lore. An explanatory circular says:—"The existence among the aboriginal nations

of South Africa of a very extensive traditionary literature is a well-known fact. Not a few stories forming part of this literature have been written down; and as in some of them terms occur which no longer appear to be used in colonial language, and the meanings of which are, in many instances, not fully understood, there is no doubt that we meet in them with literary productions of great antiquity, handed down to the present generation in a somewhat similar manner to that in which the Homeric poems reached the age of Pisistratus. But European civilization is gaining ground among the natives, and within a few years the opportunities for collecting South African folk lore will be, if not altogether lost, at least far less frequent than they are now. This would be a great loss to "the science of man," particularly as there is much which is exceptionally primitive in the languages and ideas of the South African aboriginal races. There are not a few missionaries and other Europeans in South Africa who have ample opportunities for collecting South African folk-lore. Some of these, however, are not aware of the importance of such collections, and those who are would be greatly encouraged in the task of making them if a channel for their speedy publication existed. In the hope of contributing towards the collection of South African traditionary literature, a Folk Lore Society is in course of formation at Cape Town, which already includes members in distant parts of South Africa. The publication of a small periodical every second month is also proposed by the society.

Tatooing Extraordinary.—At the Skating Theatre in Paris, there was, early in 1879, exhibited an individual of Albanian origin, tatooed in an extraordinary fashion by savages who took him prisoner. From the commencement of his hair to the soles of his feet, the colour of skin is almost complety masked by the slaty-blue tatooing. It is estimated that seven million prickings must have been made in order to force the colouring matter into the skin. A large number of animals are represented, comprising even a dodo or some such bird. It is a curious psychical fact that this man, who presents himself almost entirely naked, appears to be clothed, and gives very much less the idea of nudity than the skin-tight dress of the dancers who make their appearance at the same time. A similar fact has been remarked in Japan by Europeans: the young domestics who do not wear any clothing, are literally clad by tatooing of their skin, so as not to offend the modesty of the most delicate.

Californian Salmon for British Waters.—With reference to this subject, Sir Rose Price, in an article in the *Fishing Gazette*, says:—"The question of introducing Californian salmon into British waters is one of considerable importance to all interested in salmon fisheries, whether by net or rod; and, as within the last few months I have noticed the arrival in Europe of a considerable quantity of Californian

ova, I would bring to the notice of all who either have or contemplate introducing this fish to their waters, the extremely risky nature of the experiment they are about to make, and would advise them most strongly to pause, if there yet be time, before doing so. With regard to this new introduction there is much to be considered, but, primarily, whether they are likely to become a public benefit or an unmitigated evil. I consider their introduction the latter. Having killed and eaten salmon in almost every part of the world they inhabit, California included, I hope I shall not be considered presumptuous in giving a tolerably decided opinion as to their relative merits, and have no hesitation in saying that the best breed of salmon I have ever met with is our own, and the worst the Californian. I have eaten them when caught in tidal waters with the net, and cooked them myself on the banks of rivers far up in the Sierra Nevadas, and, though quite an eatable fish, and by no means to be despised by an hungry angler, they are far inferior in flavour to our own.

In regard to the sport of catching them, they suffer still more decidedly by comparison, as nothing will induce them to look at a fly. In the rivers MacLeod and Shasta, they occasionally take spoon and phantom, but in the Sacramento nothing tempts them except large lumps of their own roe. In rivers crowded with fish I have tried hundreds of flies, but never got a rise, and have never even met a man who had risen or killed a salmon with a fly in any part of California. Once on the end of a line, the great disadvantage in the method of getting your friend there ceases, and no fish can play gamer or stronger. I do not know a stronger or bolder fish when once hooked. But another and most serious objection to their being brought over here should be considered—viz., the fearful prevalence of disease among them. The mortality among salmon in California is simply incredible. I have seen many thousands of them dead and dying from apparently a fearful leprosy. What if, in introducing their ova, we introduce their complaints, and had we not better be careful in introducing either? Anyone going to California can have any amount of salmon-fishing for nothing, and excellent sport to boot; but please let us have no Californian salmon over here, and the sooner the Commissioners set their faces dead against the introduction the better, otherwise serious injury may be done."

Railway Work in Japan.—At the meeting of the Institution of Civil Engineers on the 10th of December, 1878, a paper on "Railway Work in Japan" was read by W. F. Potter, M. Inst. C. E. In the course of his remarks the author stated that the materials found in the country for construction were not very good, except timber, which was abundant. It was impossible to furnish any reliable information as to the cost of the works, as the Japanese officials avoided giving particulars on this point to the foreign staff. The chief engineering difficulty in Japan was the treatment of the watershed.

The beds of the rivers were nearly all higher than the surrounding country, varying from a few feet to 40 feet, or more. In some instances the railway had been taken under the rivers by tunnelling, and an example of this was given. As a rule, however, the rivers were bridged over, and approached by steep gradients, and high embankments. In the future development of railway work in Japan, two essential points were necessary—greater economy of construction, and the introduction of English capital and enterprise. These could be obtained if the principle of surface lines were adopted, and the natural jealousy of the Government of foreign interference were removed.

Diamonds in China.—M. Fauvel, who has lately been investigating the mineral wealth of the district of Shantung, gives some interesting particulars concerning the existence of small diamonds, and the method of collecting them adopted by the natives. The stones are mostly very minute, varying in size from a millet seed to a pin's head; though occasionally larger ones are met with. One recently as large as a pea was brought to Cheefoo and sold to a mandarin there. The mode adopted for collecting the diamonds is very curious. Men with thick straw shoes on walk about in the sands of the valleys and streams of the diamond mountains of Chinkangling, some 15 miles south-east of Yichow-foo. The diamonds, which are ragged and pointed, penetrate the straw and remain there. The shoes are then collected in great numbers and burnt, the diamonds being searched for in the ashes. As is the case with amethysts and rock crystal in the Lao-Shan, the priests in the temples in the Chinkangling are the principal dealers in these small diamonds. From them they are bought by glaziers at the large fairs held every year at Chuchow, Laichow-foo, and Hwang-hsien. They are not to be found in shops and are packed in quills.

The Science of Natural Philosophy.—At the opening of the winter session of 1878–9 of the University of Edinburgh, Professor Tait delivered an introductory lecture to the natural philosophy class, of which the following is an abstract. At the commencement, Professor Tait said he might be asked what right he had to suppose that natural philosophy was a science at all. In reply, he submitted that it had been found by experience and trial that dead matter was subject to certain definite laws. We had to find them out, and we tried to do so by experiment. These experiments, however, were not necessarily small, or confined to the laboratory. The planets were just, as it were, one large experiment, which we could study, and deduce from them the laws of their motion and of motion generally. Next to experiment we required for the proper advance of natural philosophy accurate language to express the results of experiments. Some terms which were engrained in the language were very bad, but as we could not get rid of them, our best plan was to give them a definite meaning, and keep them for it

only. Any combination of letters, any sound, would do if we confined it to one signification, and used it in one sense only, and not in several. Centrifugal force was a totally misleading term. We must understand by it something totally different from what we would suppose from the name. It did not mean force, nor did it mean centrifugal, but we could not get rid of it; we should see what it designated, and we should use it in that sense.

So with latent heat. It did not mean a combination of the two terms, latent and heat. It was not latent, and it was not heat; but the term should be taken as being an entirely new tern designating a particular phenomenon. So we read in the newspapers of the electric fluid and its miraculous powers. But we did not know that electricity was a fluid. Poets made free use of, and were entitled to play with the meaning of words. Scientific men were not. Whatever might be thought of poetry outside, nothing was to be thought about it in that class-room; poetry had no place there.

The next question was—How do we get our knowledge of natural phenomena? Was it objective or subjective? Let them consider the difference between light as it existed outside, and their impression of sight. Without an eye there would be no such thing as light. True, they distinguished bodies by differences in brightness in shade or colour. But outside them there was no brightness; there was just a multiplicity of waves, very minute waves. Again, sound was much the same. The noise they heard was the effect of a wave-motion in the air. But there was no sound between him and them. There was only a motion of the particles of air. These produced a sensation of noise on the nerves of the ear. To take another illustration: a pain was one thing, and the blow that caused it was another. A stone or cricket-ball flying through the air was not pain. It might be suggestive of it, and one tried to avoid it, or prevent its hurting him, if he could. But there was just as much difference between the sensation of light or sound and what caused it as between the motion of a cudgel, a stone, a brickbat, or a cricket-ball, and the pain that ensued on its striking one. They could produce sounds so shrill that they could not hear them. Waves identical in all respects but one with sound-waves might exist in the air without producing sound in the ear. So with light-waves, or waves very closely resembling them—they might exist without giving sensation of light; but they might give the sensation of heat. Heat was due to waves which were of the same kind as light, but different in length. Heat-waves were longer than light-waves. A room full of heat-waves would be dark; so would it be if it were full of chemical rays—those rays which produced photographs. It was by their sensations that they acquired knowledge of nature. But they had to examine their sensations by their reason before they used them as facts. Reason alone was perfectly helpless, and so were their senses by themselves. Men interpreted by the help of reason, and

got their knowledge only by their senses. Natural philosophers assume that matter had external existence from certain of its properties. Of the phenomena which it thrust continually on their observation, that of time was forced upon their notice by the fact of a succession of events. But to find out its nature was utterly beyond the power of any human being. They could measure it if they could get some phenomenon which could be repeated and repeated indefinitely, always in exactly the same way, and under exactly the same circumstances. This was what they really did. A pendulum measured out a succession of equal intervals of time. In it they had a means of doling out time in equal successive intervals, and these they defined as equal intervals, because precisely the same phenomena took place in these intervals.

The Milk of the Cow Tree.— Alexander Humboldt remarks that among the many very wonderful natural phenomena which he had, during his extensive travels, witnessed, none impressed him in a more wonderful degree than the sight of a tree yielding an abundant supply of milk, the properties of which seemed to be the same as the milk of a cow. The adult Indians would go each morning with their slaves from the village or station on the slope of the mountain chain bordering on Venezuela, where Humboldt was stopping, to a forest where they grew, and, making some deep incisions into the trees, in less than two hours their vessels, placed under these incisions would be full. All present would then partake of the milk, on which the slaves grew fat, and a quantity would be carried home to be given to the children, and to be mixed with cassava and maize. The tree itself attains a height of from 45 to 60 feet; has long, alternate leaves, and was described by Linden as *Brosimum galactodendron* The milk which flows from any wound made in the trunk is white and somewhat viscid; the flavour is very agreeable. Some time ago, on the occasion of M. Boussingault going to South America, Humboldt requested him to take every opportunity of investigating this subject. At Maracay the tree was first met with, and for more than a month its excellent qualities were daily tested in connection with coffee and chocolate; but there was no opportunity for a chemical analysis. Nor does such appear to have occurred till the other day, when, amid the many curious things exhibited by the Venezuelan Government at the Paris Exhibition, there happened to be several flasks of this milk, and after a long period M. Boussingault has been enabled to complete his analysis of this substance, which is unique in the vegetable world. In a memoir laid before the Academy of France he gives a detailed analysis, and concludes by stating that this vegetable milk most certainly approaches in its composition to the milk of the cow; it contains not only fatty matter, but also sugar, caseine, and phosphates. But the relative proportion of these substances is greatly in favour of the vegetable milk, and brings it up to the richness of

cream, the amount of butter in cream being about the same proportion as the peculiar waxy material found in the vegetable milk, a fact that will readily account for its great nutritive powers.

The Earnings of the Working-Classes.—The following statement of the earnings of the working classes was compiled in the close of 1878 by Professor Leone Levi, at the instance of Mr. Bass, M.P., Mr. Bass being of opinion that the prevailing distress and critical condition[1] of the working-classes would render such a statement both interesting and useful.

"The number of persons, says Professor Levi, engaged in the various industries, as returned by the census of 1871, *plus* 7 per cent. for the increase of population,[2] appears to be as follows:—

	Men.	Women	Total.
Under 20	1,511,000	1,219,000	2,730,000
20 and upwards	6,310 000	2,169,000	8,779,000
	7,821,000	3,688,000	11,509,000

"Classified according to their occupations the number stands as follows:—

Occupation	Men.	Women.	Total.
Professional, Dockyard, Police	282,000	—	282,000
Domestic service	203 000	1,849,000	2 052,000
Commercial carriers, &c	689,000	61,000	750,000
Agricultural	1,721,000	178,000	1,899,000
Industrial	4,926,000	1,600,000	6,526,000
	7,821,000	3,688,000	11,509,000

"Of children from 5 to 10 years of age there are but few now employed in consequence of the obligatory system of education; but full two-thirds of those between 10 to 15, and nearly the whole number of those from 15 to 20, belonging to the labouring classes are employed in industrial labour, and many of them earn the wages of adults. Domestic service, the textile manufactures, and agriculture employ 90 per cent. of all the women engaged in industry. In the proportion of women to men employed in industrial labour there is no material increase since 1866.

"In a population of 34,000,000, the labouring classes may be taken at 24,000,000, being about two-thirds of the whole. Therefore, the 11,509,000 earners constitute a good proportion of the whole number of the labouring classes, a fact which has an important bearing on the family income of the working population.

"The wages have increased considerably in late years, and though in some industries there has since been a reaction, in many the rise has been fully sustained. It should be remembered that when wages are paid by piece-work or by result, the skilled and

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1 The number of paupers in receipt of relief on January 1, 1878, in England and Wales was 742,703; in Scotland, May 14, 1877, 96, 404; and in Ireland, in the first week of January, 1878, 85,530—total, 924,437.

2 The population of the United Kingdom in 1871 was 31,513,000.

steady labourer often earns much more than the nominal rates, while the indolent and unskilled, earns considerably less.[3] There is much difference, moreover, in the total amount of income in the year when trade is slack, from the fewer number of days when wages are actually earned, though the rate may remain untouched.

"The following are some specimens of the wages returned to me, and upon which my calculations are based, making allowances for lower wages in country districts:—Seamen, 65*s.* to 90*s.* per month, *plus* food and berth. Printers—actual earnings in a leading house for the year 1877-8—Compositors, £103; readers, £138; pressmen, £84. Lithographers—artists, £3 to £4; writers, £3 to £4; journeymen printers, £2 to £4 per week. Bookbinders—time workers, 32*s.* to 40*s.* per week; piece workers, 38*s.* to 76*s.* Philosophical instrument makers, 7*d.* to 9*d.* per hour; when on time work, £3 3*s.* per week. Machine makers—fitters, 38*s.*; planers, 38*s.*; smiths, 36*s*, to 42*s.*; rivetters, 33*s.*; platers, 42*s.*; turners, 32*s.* to 35*s.*; pattern makers, 34*s.* to 38*s.*; planers and shotters, 18*s.* to 28*s.* Carriages—body makers, 38*s.* to 40*s.*; carriage makers, 36*s.* to 38*s.*; wheelers, 32*s.* to 34*s.*; trimmers, 34*s.* to 40*s.* Builders (London)—carpenters, masons, bricklayers, joiners, 9*d.* per hour for 52½ hours, 39*s.* 4½*d.*; plumbers, 39*s.* 2*d.*; labourers, 6*d.* per hour, 26*s.* 3*d.* Cabinetmakers—average hands, 38*s.*; best hands, 45*s.*; chair makers, average, 35*s.*; best, 40*s.*; mattress makers, 30*s.* and 40*s.*: French polishers, 28*s.* and 33*s.*; carvers, 34*s.* Cotton manufacture—minders, 27*s.* 6*d.* to 32*s.*; piecers, 25*s.*; cardroom women, 10*s.* 6*d.* to 12*s.*; men, 21*s.* 8*d.* to 22*s.* 6*d.* Jute manufacture (Dundee)—preparing women, 8*s.* to 9*s.* 6*d.*; spinners, 8*s.* 6*d.* to 11*s.*; reelers, 9*s.* to 11*s.* 6*d.* Boots and shoes (Stafford)—clickers, 25*s.* to 30*s.*; fitters, 21*s.* to 28*s.*; machinists, women, 10*s.* to 18*s.* Seamstress and dressmakers—machinists, 18*s.*; women, 16*s.* to 18*s.*; girls, 10*s.* to 12*s.* Bakers—foremen, 30*s.*; second hand, 26*s.*; *plus* bread and lodging. Sugar refining—general hands, 4*s.* 3*d.* to 4*s.* 10*d.*; pan-men, 6*s.* 8*d.* to 8*s.* 2*d.*; figure men, 5*s.* to 5*s.* 10*d.*; piece work—wet char, 7*s.* 1*d.* to 7*s.* 2*d.*; dry char, 6*s.* 1*d.* Brewers—racking room, 20*s.*; hopping, 20*s.*; grainers, 21*s.*; labourers 18*s.* Gold and silver chasers—first class, £4 to £5; ordinary, £2 to £3. Silversmiths—first class, £2 10*s.* to £3; ordinary, 38*s.* to 42*s.* Mining and agricultural wages vary considerably, 13*s.* to 20*s.* Iron workers—roller firemen, 30*s.* to 50*s.*; assistants, 20*s.* to 30*s.*; hot bar drawers, 12*s.* 6d. to 25*s.*; puddle bar weighers, 24*s.* to 30*s.*; furnace men, 35*s.* to 50*s.*

"The wages, it will be seen, are in most cases good; but I have taken lower rates for my averages, seldom, indeed, assuming even 33*s.* and 35*s.* a week in the most skilled arts. Upon a full calculation of all the high-paid and low-

[3] A house in Birmingham furnished me with an abstract of wages earned in the six months from July 1, 1877, to December 1, 1877, when they were in full work, as follows —Moulder, average pay, received £2 3*s.* 4*d.*; ordinary pay, £1 16*s.*; fitter, £2 15*s.* 10*d.* and £1 16*s.*; ditto, £2 3*s.* and £1 14*s.*; engine-man, £2 11*s.* 6*d.* and £1 6*s.*; labourer, £1 6*s.* 6*d.* and £1.

paid industries, and assuming fair average wages in each and all cases, I find that the total amount of earning is considerable, and that the result fully confirms the accuracy of my calculations in 1866. The proportion of produce which falls on labour differs considerably in the different industries, but it is in the nature of British industry, which consists mainly in manufactured goods and artistic products, to require much labour. Hence greater conflicts between capital and labour in England than in other countries. Nowhere, indeed, are such masses of labouring populations to be found as in the manufacturing districts of Britain.

"The total amount of gross earnings of the working classes of the United Kingdom, under a condition of an average amount of employment and at present rates, I ascertained to be £503,000,000, viz.:—

	Men.	Women	Total
Under 20	£32,000,000 ..	£29,000,000 ..	£61,000,000
20 and upwards..	358,000,000 .	84,000,000 ..	442,000,000
	£390,000,000	£113,300,000	£503,000,000

"Divided according to different industries the amount is as follows:—

Occupations.	Men.	Women.	Total.
Professional, Dockyards, Police, Army, Navy	£14,000,000 ..	£ —	£14,000,000
Domestic Service	9,000,000 ..	61,000,000 ..	70,000,000
Commercial Carriers, &c.	31,000,000 .	— ..	31,000,000
Agricultural	57,000,000	4,000,000 ..	61,000 000
Industries	279,000,000 .	48 000,000 ..	327,000,000
Total	£390,000,000	£113,000,000	£503,000,000

"From this important deductions must be made. In my report in 1866 I have only taken the number of workers up to 60 years of age, and I have set the earnings of all above that age against the amount lost in the year from holidays and other suspensions of labour, amounting in all to about four weeks, or $7\frac{1}{2}$ per cent. This year I have taken the entire number of labourers; therefore, we must deduct that $7\frac{1}{2}$ per cent., and also $2\frac{1}{2}$ per cent. for the number of masters not distinguished in the census, making in all 10 per cent, or £50,300,000, leaving a total of £452,700,000.

"But yet another important deduction must be made at this time from the stagnation of trade, and, consequently, diminished demand of labour. The depression has hitherto been reported to exist mainly in the textile industries, mining and metal manufactures, and among that class of labourers of an indefinite character who are always the first to suffer when work is slack; and these represent a total amount of earnings as follows:—

	Labourers.	Earnings.
Textile Manufactures..	2,300,000 ..	£90,000,000
Mining	625,000 ..	26.000,000
Metal Manufacture	628,000 ..	41,000,000
Miscellaneous	686,000 ..	25,000,000
Total	4,239,000	£182,000,000

"Allowing for a loss of wages in these industries (though in many branches included within these divisions, as you will see in the details, no depression exists) to the extent of two months additional, equal to one-sixth of the yearly income, amounting in all to about £30,000,000, the earnings of the labouring classes will be reduced to £422,700,000, an amount almost equal to that of 1866, divided, however, among a much larger number of labourers.

"The average wages represented by the total amount of earnings, divided among the respective number of earners, shows some increase as compared with 1866, as follows:—

	Men. Under 20 Per week.	Men. 20 and upwards Per week	Women. Under 20. Per week.	Women. 20 and upwards, Per week.
	s. d.	s. d.	s. d.	s. d.
1866	7 6	19 6	8 0	11 0
1878	8 0	21 9	9 0	13 8
Increase per cent . .	6⅔	6¾	12	24

"You will see that women's wages have advanced more in proportion than men's wages. This is especially the case among domestic servants and dressmakers.

"Taken separately, the average wages are not high; yet if the total amount earned be divided among the 4,800,000 families (each of 5 represented in the 24,000,000), the amount per family is £94, without the deduction for the depression of trade, and £88 with that reduction—viz., 36s. in the first case or 33s. in the latter—an ample allowance for comfortable living, having regard especially to the present cheapness of almost every article of food and dress as well as coal.

"Within the last 12 years our labouring classes have had opportunies of setting aside a considerable amount, and there ought to be no reason for the excessive distress complained of at this moment. A certain amount has doubtless been saved by the thrifty and careful, as witnessed by the larger amount held by the savings-banks, friendly, and building societies,[4] a large portion of which belongs to the working classes. But a considerable proportion of the extra amount earned, especially from 1871 to 1873, has been spent in maintaining a standard of comfort higher, probably, than a labouring

[4] The amount held by the savings-banks in 1866 and 1877 was as follows:—

	1866.	1877.
Trustee Savings-Bank	£36,382,000 ..	44,239,000
Post Office Savings-Bank	8,121,000 ..	28,741,000
	£44,503,000 ..	72,980,000
Increase	28,477,000.	

The amounts held by friendly societies in 1865 was £5,362,000, and in 1874, £9,038,000—increase, £3,676,000 Total of both savings-banks and friendly societies, in ten years £32,113,000, or an average of £3,200,000 per annum.

On the 31st of December, 1877, the liabilities of building societies, in which the working classes have largely invested, to the holders of subscription or incomplete shares, of completed or realized shares, and of preferential shares to depositors, and also for unappropriated profits were—in England and Wales, £23,916,000· Scotland, £1,126,000; and Ireland, 6£78,000—total, £25,720,000.

man is warranted in looking for, unless he has first put by something for the rainy day, and more especially in an excessive expenditure for eating, drinking, and smoking.[5] A wiser and a more economical appropriation of wages is the great want of the British working population.

"In no other country are the wages more liberal, but in no other country are they more wastefully used than in the United Kingdom. Here there is scope enough for practical education touching the moral, as important as the intellectual, bringing up of the new generation."

Artificial Manures in France.—It is estimated that artificial manures of the value of about 800,000,000 francs are used in France, but M. de Molon supposes that the total includes fraudulent manures, agriculturally useless, to a value of 300,000,000 francs. If farmers could be certain of the useful quality of the manure they purchase, the consumption would be speedily doubled. M. de Molon now produces a manure suitable to agriculture, with seaweed or wrack, such as is found abundantly on the French coasts, and powdered phosphate of lime. He mixes these in successive layers in pits or sheds, in proportions best adapted for fermentation (proportions which vary with the nature of the phosphates used, the moisture and variety of the seaweed, &c.) This mixture is allowed to ferment six weeks to two months, according as the season is hotter or colder; then, if the decomposition is not complete, the compost is mixed anew, for fresh fermentation till the wrack is entirely decomposed. The manure thus produced contains, besides phosphate of lime, all the elements of fertilisation contained in the vegetable matters, viz., nitrogen, mineral salts, soda, potash, and magnesia.

New Thermometers.—A number of metallic thermometers of various size and form have been recently manufactured by M. Coret, of Paris. They are made by uniting end to end and parallelly, several equal-sized tubes of different metals (steel and zinc, *e.g.*) These junctions being alternate, the differences of dilatation between the tubes of different metals are added together, and give the last tube sufficient motion to be amplified by means of a toothed wheel or by levers, so that the index-needle shows considerable displacement, enabling one to appreciate fractions of a degree. The metals being good conductors, the indications of these thermometers are rapid when the metallic rod is in contact with the body whose temperature is to be measured. One interesting application of the system is that of a medical thermometer, in which the tubes are to be concentrated in a space of two centimètres, so as to be suitable for all determinations.

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[5] The consumption of the following imported and exciseable articles of food and drink per head of the population in 1866 and 1877 was as follows —

	1866.	1877.	Increase.
Bacon and Ham	2·13	8·04	277
Wheat and Wheat Flour (lb.)	104·50	203·26	94
Sugar (lb.)	21·21	64·06	57
Tea (lb.)	3·42	4·52	32
Tobacco (lb.)	1·39	1·49	10
Spirits (gallons)	1·01	1·23	21
Malt (bushels)	1·82	1·92	5

XIII.—THE BRITISH ASSOCIATION.

PRESIDENT'S ADDRESS.

Delivered by Professor G. J. ALLMAN, *M.D., LL.D., F.R.S.S.L. and E., M.R.I.A., Pres. L.S., at Sheffield, on the 20th of August,* 1879.

It is no easy thing to find material suited to an occasion like the present. For on the one hand there is risk that a presidential address may be too special for an audience necessarily large and general, while on the other hand it may treat too much of generalities to take hold of the sympathies and command the attention of the hearers.

It may be supposed that my subject should have been suggested by the great manufacturing industries of the town which has brought us together; but I felt convinced that a worker in only the biological sciences could not do justice to the workers in so very different a field.

I am not, therefore, going to discourse to you of any of those great industries which make civilized society what it is—of those practical applications of scientific truth which within the last half century have become developed with such marvellous rapidity, and which have already become interwoven with our everyday life, as the warp of the weaver is interwoven with the woof. Such subjects must be left to other occupiers of this chair, from whom they may receive that justice which I could not pretend to give them; and I believe I shall act most wisely by keeping to a field with which my own studies have been more directly connected.

I know that there are many here present from whom I have no right to expect that previous knowledge which would justify me in dispensing with such an amount of elementary treatment as can alone bring my subject intelligibly before them, and my fellow members of the British Association who have the advantage of being no novices in that department of biology, with which I propose to occupy you, will pardon me if I address myself mainly to those for whom the field of research on which we are about to enter has now been opened for the first time.

I have chosen, then, as the matter of my address to you to-night, a subject in whose study there has during the last few years prevailed an unwonted amount of activity, resulting in the discovery of many remarkable facts, and the justification of many significant generalisations. I propose, in short, to give you, in as untechnical a form as possible, some account of the most generalised expression of living

matter, and of the results of the more recent researches into its nature and phenomena.

More than forty years have now passed away since the French naturalist Dujardin drew attention to the fact that the bodies of some of the lowest members of the animal kingdom consist of a structureless, semi-fluid, contractile substance, to which he gave the name of Sarcode. A similar substance occurring in the cells of plants was afterwards studied by Hugo von Mohl, and named by him Protoplasm. It remained for Max Schultze to demonstrate that the sarcode of animals and the protoplasm of plants were identical.

The conclusions of Max Schultze have been in all respects confirmed by subsequent research, and it has further been rendered certain that this same protoplasm lies at the base of all the phenomena of life, whether in the animal or the vegetable kingdom. Thus has arisen the most important and significant generalisation in the whole domain of biological science.

Within the last few years protoplasm has again been made a subject of special study: unexpected and often startling facts have been brought to light, and a voluminous literature has gathered round this new centre of research. I believe, therefore, that I cannot do better than call your attention to some of the more important results of these inquiries, and endeavour to give you some knowledge of the properties of protoplasm, and of the part it plays in the two great kingdoms of organic nature.

As has just been said, protoplasm lies at the base of every vital phenomenon. It is, as Huxley has well expressed it, "the physical basis of life." Wherever there is life, from its lowest to its highest manifestations, there is protoplasm; wherever there is protoplasm, there, too, is life. Thus, co-extensive with the whole of organic nature—every vital act being referable to some mode or property of protoplasm—it becomes to the biologist what the ether is to the physicist; only that instead of being a hypothetical conception, accepted as a reality from its adequacy in the explanation of phenomena, it is a tangible and visible reality, which the chemist may analyse in his laboratory, the biologist scrutinise beneath his microscope and his dissecting needle.

The chemical composition of protoplasm is very complex, and has not been exactly determined. It may, however, be stated that protoplasm is essentially a combination of albuminoid bodies, and that its principal elements are, therefore, oxygen, carbon, hydrogen, and nitrogen. In its typical state it presents the condition of a semi-fluid substance—a tenacious, glairy liquid, with a consistence somewhat like that of the white of an unboiled egg.[1]

[1] In speaking of protoplasm as a liquid, it must be borne in mind that this expression refers only to its physical consistence—a condition depending mainly on the amount of water with which it is combined, and subject to considerable variation, from the solid form in which we find it in the dormant embryo of seeds, to the thin watery state in which it occurs in the leaves of Valisneria. Its distinguishing properties are totally different from those of a purely physical liquid, and are subject to an entirely different set of laws.

While we watch it beneath the microscope, movements are set up in it; waves traverse its surface, or it may be seen to flow away in streams, either broad and attaining but a slight distance from the main mass, or else stretching away far from their source, as narrow liquid threads, which may continue simple, or may divide into branches, each following its own independent course; or the streams may flow one into the other, as streamlets would flow into rivulets and rivulets into rivers, and this not only where gravity would carry them, but in a direction diametrically opposed to gravitation; now we see it spreading itself out on all sides into a thin liquid stratum, and again drawing itself together within the narrow limits which had at first confined it, and all this without any obvious impulse from without which would send the ripples over its surface or set the streams flowing from its margin. Though it is certain that all these phenomena are in response to some stimulus exerted on it by the outer world, they are such as we never meet with in a simply physical fluid—they are spontaneous movements resulting from its proper irritability, from its essential constitution as living matter.

Examine it closer, bring to bear on it the highest powers of your microscope—you will probably find disseminated through it countless multitudes of exceedingly minute granules; but you may also find it absolutely homogeneous, and, whether containing granules or not, it is certain that you will find nothing to which the term *organisation* can be applied. You have before you a glairy, tenacious fluid, which, if not absolutely homogeneous, is yet totally destitute of structure.

And yet, no one who contemplates this spontaneously moving matter can deny that it is alive. Liquid as it is, it is a living liquid; organless and structureless as it is, it manifests the essential phenomena of life.

The picture which I have thus endeavoured to trace for you in a few leading outlines is that of protoplasm in its most generalised aspect. Such generalisations, however, are in themselves unable to satisfy the conditions demanded by an exact scientific inquiry, and I propose now, before passing to the further consideration of the place and purport of protoplasm in nature, to bring before you some definite examples of protoplasm, such as are actually met with in the organic world.

A quantity of a peculiar slimy matter was dredged in the North Atlantic by the naturalists of the exploring ship *Porcupine* from a depth of from 5,000 to 25,000 feet. It is described as exhibiting, when examined on the spot, spontaneous movements, and as being obviously endowed with life. Specimens of this, preserved in spirits, were examined by Professor Huxley, and declared by him to consist of protoplasm, vast masses of which must thus in a living state extend over wide areas of sea bottom. To this wonderful slime Huxley gave the name of *Bathybius Haeckelii.*

Bathybius has since been sub-

jected to an exhaustive examination by Professor Haeckel, who believes that he is able to confirm in all points the conclusions of Huxley, and arrives at the conviction that the bottom of the open ocean, at depths below 5,000 feet, is covered with an enormous mass of living protoplasm, which lingers there in the simplest and most primitive condition, having as yet acquired no definite form. He suggests that it may have originated by spontaneous generation, but leaves this question for future investigations to decide.

The reality of Bathybius, however, has not been universally accepted. In the more recent investigations of the *Challenger* the explorers have failed in their attempts to bring further evidence of the existence of masses of amorphous protoplasm spreading over the bed of the ocean. They have met with no trace of Bathybius in any of the regions explored by them, and they believe that they are justified in the conclusion that the matter found in the dredgings of the *Porcupine* and preserved in spirits for further examination, was only an inorganic precipitate due to the action of the alcohol.

It is not easy to believe, however, that the very elaborate investigations of Huxley and Haeckel can be thus disposed of. These, moreover, have received strong confirmation from the still more recent observations of the Arctic voyager Bessels, who was one of the explorers of the ill-fated *Polaris*, and who states that he dredged from the Greenland seas masses of living undifferentiated protoplasm. Bessels assigns to these the name of Protobathybius, but they are apparently indistinguishable from the Bathybius of the *Porcupine*. Further arguments against the reality of Bathybius will, therefore, be needed before a doctrine founded on observations so carefully conducted shall be relegated to the region of confuted hypotheses.

Assuming then that Bathybius, however much its supposed wide distribution may have been limited by more recent researches, has a real existence, it presents us with a condition of living matter the most rudimental it is possible to conceive. No law of morphology has as yet exerted itself in this formless slime. Even the simplest individualisation is absent. We have a living mass, but we know not where to draw its boundary lines; it is living matter, but we can scarcely call it a living being.

We are not, however, confined to Bathybius for examples of protoplasm in a condition of extreme simplicity. Haeckel has found, inhabiting the fresh waters in the neighbourhood of Jena, minute lumps of protoplasm, which, when placed under the microscope, were seen to have no constant shape, their outline being in a state of perpetual change, caused by the protrusion from various parts of their surface of broad lobes and thick finger-like projections, which, after remaining visible for a time, would be withdrawn, to make their appearance again on some other part of the surface.

These changeable protrusions of its substance, without fixed

position or definite form, are eminently characteristic of protoplasm in some of its simplest conditions. They have been termed "Pseudopodia," and will frequently come before you in what I have yet to say.

To the little protoplasmic lumps thus constituted, Haeckel has given the name of *Protamœba primitiva*. They may be pared to minute detached pieces of Bathybius. He has seen them multiplying themselves by spontaneous division into two pieces, which, on becoming independent, increase in size and acquire all the characters of the parent.

Several other beings as simple as *Protamœba* have been described by various observers, and especially by Haeckel, who brings the whole together into a group to which he gives the name of MONERA, suggested by the extreme simplicity of the beings included in it.

But we must now pass to a stage a little higher in the development of protoplasmic beings. Widely distributed in the fresh and salt waters of Britain, and probably of almost all parts of the world, are small particles of protoplasm closely resembling the *Protamœba* just described. Like it, they have no definite shape, and are perpetually changing their form, throwing out and drawing in thick lobes and finger-like pseudopodia, in which their body seems to flow away over the field of the microscope. They are no longer, however, the homogeneous particle of protoplasm which forms the body of *Protamœba*. Towards the centre a small globular mass of firmer protoplasm has become differentiated off from the remainder, and forms what is known as a nucleus, while the protoplasm forming the extreme outer boundary differs slightly from the rest, being more transparent, destitute of granules, and apparently somewhat firmer than the interior. We may also notice that at one spot a clear spherical space has made its appearance, but that while we watch it has suddenly contracted and vanished, and after a few seconds has begun to dilate so as again to come into view, once more to disappear, then again to return, and all this in regular rhythmical sequence. This little rhythmically pulsating cavity is called the "contractile vacuole." It is of very frequent occurrence among those beings which lie low down in the scale of life.

We have now before us a being which has arrested the attention of naturalists almost from the commencement of microscopical observation. It is the famous *Amœba*, for which ponds and pools and gutters on the house roof have for the last 200 years been ransacked by the microscopist, who has many a time stood in amazement at the undefinable form and Protean changes of this particle of living matter. It is only the science of our own days, however, which has revealed its biological importance, and shown that in this little soft nucleated particle we have a body whose significance for the morphology and physiology of living beings cannot be over estimated, for in *Amœba* we have the essential characters of a CELL, the morphological unit of organisation,

the physiological source of specialised function.

The term "cell" has been so long in use that it cannot now be displaced from our terminology; and yet it tends to convey an incorrect notion, suggesting, as it does, the idea of a hollow body or vesicle, this having been the form under which it was first studied. The cell, however, is essentially a definite mass of protoplasm having a nucleus imbedded in it. It may, or may not, assume the form of a vesicle; it may, or may not, be protected by an enveloping membrane; it may, or may not, contain a contractile vacuole; and the nucleus may, or may not, contain within it one or more minute secondary nuclei or "nucleoli."

Haeckel has done good service to biology in insisting on the necessity of distinguishing such non-nucleated forms as are presented by *Protamœba* and the other *Monera* from the nucleated forms as seen in *Amœba*. To the latter he would restrict the word *cell*, while he would assign that of *cytode* to the former.[2]

[2] In every typical cell three parts may be distinguished. There is first the more or less liquid granular protoplasm; secondly the nucleus; and thirdly an external more firm zone of protoplasm, known as the "cortical layer"—the Hautschicht of the German histologists. All these parts may be regarded as portions differentiated out of the original simple protoplasm. Cells do not, however, always remain on a stage of such simplicity as that presented by *Amœba*. The nucleus is always at its origin quite homogeneous, but as it increases in size it usually manifests a differentiation resulting in a constitution which recent research has shown to be more complex than had been previously supposed; for we often find it to present an external firmer layer, or nuclear membrane, including within it the softer nuclear protoplasm, in which again a network of filaments has been in many instances described.

The structure of the nucleus has been quite recently studied by Flemming (*Arch. f. mikr. Anat.*, Band xvi. Heft 2, 1878), who has given particular attention to this intranuclear network. He maintains that in its completed state the nucleus consists of a parietal firm layer, which incloses, besides specially differentiated nucleoli, a framework (Gerust) of filaments with a more fluid intervening substance. He further insists on the fact that, with the differentiation of a nucleus, there is introduced a chemical difference between its substance and that of the surrounding cell substance, as shown not only by a different behaviour of the nucleus towards re-agents, but by an actually determined difference of chemical composition.

Klein (*Quarterly Journ. Micr. Sci.* vol. xviii. p. 315) has shown that in the cells of the stomach of *Triton cristatus* there is a delicate intranuclear network of filaments in all respects resembling that described by Flemming, and he further maintains that the network of the nucleus is here continuous, through minute apertures near the poles of the nuclear membrane, with a similar network in the surrounding cell-substance. In this cell-substance he distinguishes two parts—the homogeneous ground substance and the intracellular network of filaments.

Flemming, however, will not admit this connection between intra-nuclear and intra-cellular filaments, and Schleicher, as the result of his very recent researches on the division of cartilage-cells ("Die Knorpelzelltheilung," *Arch. f mikr. Anat.*, Band xvi. Heft 2, 1878), concludes that in these there is no true intra-cellular network, the nucleus being here composed of a multitude of separate rodlets, filaments, and granules surrounded by the nuclear membrane.

The minute granules which are generally seen in the soft protoplasm of the cell do not seem to be essential constituents. They are probably nutritive matter introduced from without, and in process of assimilation and conversion into proper protoplasm. Hanstein has distinguished by the term Metaplasm these granules from the proper homogeneous protoplasm in which they are suspended. The external cortical layer is quite destitute of them: on this devolves the property of protecting the contents from the unfavourable action of outer influences, and to it alone in plants is allocated the property of secreting the cellulose boundary wall.

Let us observe our *Amœba* a little closer. Like all living beings it must be nourished. It cannot grow as a crystal would grow by accumulating on its surface molecule after molecule of matter. It must *feed*. It must take into its substance the necessary nutriment; it must assimilate this nutriment, and convert it into the material of which it is itself composed.

If we seek, however, for a mouth by which the nutriment can enter into its body, or a stomach by which this nutriment can be digested, we seek in vain. Yet watch it for a moment as it lies in a drop of water beneath our microscope. Some living denizen of the same drop is in its neighbourhood, and its presence exerts on the protoplasm of the *Amœba* a special stimulus which gives rise to the movements necessary for the prehension of nutriment. A stream of protoplasm instantly runs away from the body of the *Amœba* towards the destined prey, envelopes it in its current, and then flows back with it to the central protoplasm, where it sinks deeper and deeper into the soft yielding mass, and becomes dissolved, digested, and assimilated in order that it may increase the size and restore the energy of its captor.

But again, like all living things, *Amœba* must multiply itself, and so after attaining a certain size its nucleus divides into two halves, and then the surrounding protoplasm becomes similarly cleft, each half retaining one half of the original nucleus. The two new nucleated masses which thus arise now lead an independent life, assimilate nutriment, and attain the size and characters of the parent.

We have just seen that in the body of an *Amœba* we have the type of a cell. Now both the fresh waters and the sea contain many living beings beside *Amœba* which never pass beyond the condition of a simple cell. Many of these, instead of emitting the broad lobe-like pseudopodia of *Amœba*, have the faculty of sending out long thin threads of protoplasm, which they can again retract, and by the aid of which they capture their prey or move from place to place. Simple structureless protoplasm as they are, many of them fashion for themselves an outer membranous or calcareous case, often of symmetrical form and elaborate ornamentation, or construct a siliceous skeleton of radiating spicula, or crystal clear concentric spheres of exquisite symmetry and beauty.

Some move about by the aid of a flagellum, or long whip-like projection of their bodies, by which they lash the surrounding waters,

Several recent observers, but more especially Strasburger ("Studien uber das Protoplasma," *Jenaische Zeitschr.*, 1876), have described in the cortical layer of various cells a radial striation, as if formed by excessively delicate rodlets (Stabchen), placed vertically to the surface and in close proximity to one another. He has seen a relation between these and the cilia on the swarm spores of Vaucheria, where each cilium seems to be supported by a rodlet. That this condition of the cortical layer, however, has not a general feature of cell protoplasm, is certain, it is but a special case of structural differentiation. Indeed, the complex structure which has been detected in the nucleus and in the surrounding cell-protoplasm can scarcely be otherwise regarded than as an expression of an early differentiation in the structure of the cell, and not, as has been maintained, an ultimate or "plastidular" condition of protoplasm.

and which, unlike the pseudopodia of *Amœba*, cannot, during active life, be withdrawn into the general protoplasm of the body; while among many others locomotion is effected by means of cilia—microscopic vibratible hairs, which are distributed in various ways over the surface, and which, like the pseudopodia and flagella, are simple prolongations of their protoplasm. In every one of these cases the entire body has the morphological value of a cell, and in this simple cell reside the whole of the properties which manifest themselves in the vital phenomena of the organism.

The part fulfilled by these simple unicellular beings in the economy of nature has at all times been very great, and many geological formations, largely built up of their calcareous, or silicious, skeletons, bear testimony to the multitudes in which they must have swarmed in the waters of the ancient earth.

Those which have thus come down to us from ancient times owe their preservation to the presence of the hard persistent structures secreted by their protaplasm, and must, after all, have formed but a very small proportion of the unicellular organisms which peopled the ancient world, and there fulfilled the duties allotted to them in nature, but whose soft, perishable bodies have left no trace behind.

In our own day similar unicellular organisms are at work, taking their part silently and unobtrusively in the great scheme of creation, and mostly destined, like their predecessors, to leave behind them no record of their existence. The Red Snow Plant, to which is mainly due the beautiful phenomenon by which tracts of Arctic and Alpine snow become tinged of a delicate crimson, is a microscopic organism whose whole body consists of a simple spherical cell. In the protoplasm of this little cell must reside all the essential attributes of life; it must grow by the reception of nutriment; it must repeat by multiplication that form which it has itself inherited from its parent; it must be able to respond to the stimulus of the physical conditions by which it is surrounded. And there it is, with its structure almost on the bounds of extremest simplification, taking its allotted part in the economy of nature, combining into living matter the lifeless elements which lie around it, redeeming from sterility the regions of never-thawing ice, and peopling with its countless millions the wastes of the snow land [3]

But organisation does not long rest on this low stage of unicellular simplicity, for as we pass from these lowest forms into higher, we find cell added to cell, until many millions of such units become associated in a single organism, where each cell, or each group of cells, has its own special work, while all combine for the welfare and unity of the whole.

In the most complex animals, however, even in man himself,

[3] The Red Snow Plant (*Protococcus nivalis*) acts on the atmosphere through the agency of chlorophyll, like the ordinary green plants. As in these, chlorophyll is developed in it, and is only withdrawn from view by the predominant red pigment to which the *Protococcus* owes one of its most striking characteristics.

the compotent cells, notwithstanding their frequent modification, and the usual intimacy of their union, are far from losing their individuality. Examine under the microscope one drop of blood freshly taken from the human subject, or from any of the higher animals. It is seen to be composed of a multitude of rod corpuscles, swimming in a nearly colourless liquid, and along with these, but in much smaller numbers, somewhat larger colourless corpuscles. The red corpuscles are modified cells, while the colourless corpuscles are cells still retaining their typical form and properties. These last are little masses of protoplasm, each involving a central nucleus. Watch them. They will be seen to change their shape; they will project and withdraw pseudopodia, and creep about like an *Amœba*. But, more than this, like an *Amœba*, they will take in solid matter as nutriment. They may be fed with coloured food, which will then be seen to have accumulated in the interior of their soft transparent protoplasm; and, in some cases, the colourless blood corpuscles have actually been seen to devour the more diminutive of their companions, the red ones.

Again, there are certain cells filled with peculiar coloured matters, and called pigment cells, which are especially abundant, as constituents of the skin in fishes, frogs, and other low vertebrate, as well as many invertebrate, animals. Under certain stimuli, such as that of light, or of emotion, these pigment cells change their form, protrude or retract pseudopodial prolongations of their protoplasm, and assume the form of stars or of irregularly lobed figures, or again draw themselves together into little globular masses. To this change of form in the pigment cell the rapid change of colour so frequently noticed in the animals provided with them is to be attributed.

The animal egg, which in its young states forms an element in the structure of the parent organism, possesses in the relations now under consideration a peculiar interest. The egg is a true cell, consisting essentially of a lump of protoplasm inclosing a nucleus, and having a nucleoclus included in the interior of the nucleus. While still very young it has no constant form, and is perpetually changing its shape. Indeed, it is often impossible to distinguish it from an *Amœba*; and it may, like an *Amœba*, wander from place to place by the aid of its pseudopodial projections. I have shown elsewhere[4] that the primitive egg of the remarkable hydroid *Myriothela*, manifests amœboid motions; while Haeckel has shown[5] that in the sponges certain *Amœba*-like organisms, which are seen wandering about in the various canals and cavities of their bodies, and had been until lately regarded as parasites which had gained access from without, are really the eggs of the sponge; and a similar amœboid condition is presented by the very young eggs of even the highest animals.

[4] 'On the Structure and Development of *Myriothela*,' *Phil. Trans.*, vol clxv., 1875, p. 552.

[5] *Jenaische Zeitschr.*, 1871.

Again, Reichenbach has proved[6] that during the development of the crayfish the cells of the embryo throw out pseudopodia by which, exactly as in an *Amœba*, the yolk spheres which serve as nutriment for the embryo are surrounded and engulphed in the protoplasm of the cells.

I had shown some years ago[7] that in *Myriothela*, pseudopodial processes are being constantly projected from the walls of the alimentary canal into its cavity. They appear as direct extensions of a layer of clear, soft, homogeneous protoplasm which lies over the surface of the naked cells lining the cavity, and which I now regard as the "Hautschicht" or cortical layer of these cells. I then suggested the function of these pseudopodia lay in seizing, the manner of an *Amœba*, such alimentary matter as may be found in the contents of the canal, and applying it to the nutrition of the hydroid.

What I had thus suggested with regard to *Myriothela* has been since proved in certain planarian worms by Metschnikoff,[8] who has seen the cells which line the alimentary canal in these animals act like independent *Amœbæ*, and engulph in their protoplasm such solid nutriment as may be contained in the canal. When the planaria was fed with colouring matter these amœboid cells became gorged with the coloured particles just as would have happened in an *Amœba* when similarly fed.

But it is not alone in such loosely aggregated cells as those of the blood, or in the amœboid cells of the alimentary canal, or in such scattered constituents of the tissues as the pigment cells, or in cells destined for an ultimate state of freedom, as the egg, that there exists an independence. The whole complex organism is a society of cells, in which every individual cell possesses an independence, an autonomy, not at once so obvious as in the blood cells, but not the less real. With this autonomy of each element there is at the same time a subordination of each to the whole, thus establishing a unity in the entire organism, and a concert and harmony between all the phenomena of its life.

In this society of cells each has its own work to perform, and the life of the organism is made up of the lives of its component cells. Here it is that we find most distinctly expressed the great law of the physiological division of labour. In the lowest organisms, where the whole being consists of a single cell, the performance of all the processes which constitute its life must devolve on the protoplasm of this one cell; but as we pass to more highly organised beings, the work becomes distributed among a multitude of workers. These workers are the cells which now make up the complex organism. The distribution of labour, however, is not a uniform one, and we are not to suppose that the work performed by each cell is but a repetition of that of every other. For the

6 "Die Embryonanlage und erste Entwickelung des Flusskrebse," *Zeitschr. f. wissens. Zoologie*, 1877.

7 *Loc cit.*

8 "Ueber die Verdauungsorgane einiger Susswasser-Turbellarien," *Zoologischer Anzeiger*, December, 1878.

life processes, which are accumulated in the single cell of the unicellular organism, become in the more complex organism differentiated, some being intensified and otherwise modified and allocated to special cells, or to special groups of cells, which we call organs, and whose proper duty is now to take charge of the special processes which have been assigned to them. In all this we have a true division of labour—a division of labour, however, by no means absolute; for the processes which are essential to the life of the cell must still continue common to all the cells of the organism. No cell, however great may be the differentiation of function in the organism, can dispense with its irritability, the one constant and essential property of every living cell. There thus devolves on each cell or group of cells some special work which contributes to the well-being of all, and their combined labours secure the necessary conditions of life for every cell in the community, and result in those complex and wonderful phenomena which constitute the life of the higher organisms.

We have hitherto considered the cell only as a mass of active nucleated protoplasm, either absolutely naked or partially inclosed in a protective case, which still permits free contact of the protoplasm with the surrounding medium. In very many instances, however, the protoplasm becomes confined within resisting walls, which entirely shut it in from all direct contact with the medium which surrounds it. With the plant this is almost always so after the earliest stages of its life. Here the protoplasm of the cells is endowed with the faculty of secreting over its surface a firm, resisting membrane, composed of cellulose, a substance destitute of nitrogen, thus totally different from the contained protoplasm, and incapable of manifesting any of the phenomena of life.

Within the walls of cellulose the protoplasm is now closely imprisoned, but we are not on that account to suppose that it has lost its activity, or has abandoned its work as a living being. Though it is now no longer in direct contact with the surrounding medium, it is not the less dependent on it, and the reaction between the imprisoned protoplasm and the outer world is still permitted by the permeability of the surrounding wall of cellulose.

When the protoplasm thus becomes surrounded by a cellulose wall it seldom retains the uniform arrangement of its parts which is often found in the naked cells. Minute cavities or vacuoles make their appearance in it; these increase in size and run one into the other, and may finally form one large cavity in the centre, which becomes filled with a watery fluid, known as the cell sap. This condition of the cell was first observed, and it was it which suggested the often inapplicable term "cell." By the formation of this central sap cavity the surrounding protoplasm is pushed aside, and pressed against the cellulose wall, over which it now extends as a continuous layer. The nucleus either continues near the centre, enveloped by a layer of protoplasm, which is connected

by radiating bands of protoplasm with that of the walls, or it accompanies the displaced protoplasm, and lies embedded in this on the walls of the cell.

We have abundant evidence to show that the imprisoned protoplasm loses none of its activity. The *Characeæ* constitute an exceedingly interesting group of simple plants, common in the clear water of ponds and of slowly running streams. The cells of which they are built up are comparatively large, and, like almost all vegetable cells, are each inclosed in a wall of cellulose. The cellulose is perfectly transparent. and if the microscope, even with a low power, be brought to bear on one of these cells, a portion of its protoplasm may be seen in active rotation, flowing up one side of the long tubular cell and down the other, and sweeping on with it such more solid particles as may become enveloped in its current. In another water plant, the *Valisneria spiralis*, a similar active rotation of the protoplasm may be seen in the cells of the leaf, where the continuous stream of liquid protoplasm sweeping along the green granules of chlorophyll, and even carrying the globular nucleus with it in its current, presents one of the most beautiful of the many beautiful phenomena which the microscope has revealed to us.

In many other cells with large sap cavities, such as those which form the stinging hairs of nettles and other kinds of vegetable hairs, the protoplasmic lining of the wall may send off into the sap cavity projecting ridges and strings, forming an irregular network, along which, under a high power of the microscope, a slow streaming of granules may be witnessed. The form and position of this protoplasmic network undergo constant changes, and the analogy with the changes of form in an *Amœba* becomes obvious. The external wall of cellulose renders it impossible for the confined protoplasm to emit, like a naked *Amœba*, pseudopodia from its outer side; but on the inner side there is no obstacle to the extension of the protoplasm, and here the cavity of the cell becomes more or less completely traversed by protoplasmic projections from the wall. These often stretch themselves out in the form of thin filaments, which, meeting with a neighbouring one, become fused into it; they show currents of granules streaming along their length, and after a time become withdrawn and disappear. The vegetable cell, in short, with its surrounding wall of cellulose, is in all essential points a closely imprisoned Rhizopod.

Further proof that the imprisoned protoplasm has lost by its imprisonment none of its essential irritability, is afforded by the fact that if the transparent cell of a Nitella, one of the simple water plants just referred to, be touched under the microscope with the point of a blunt needle, its green protoplasm will be seen to recede, under the irritation of the needle, from the cellulose wall. If the cellulose wall of the comparatively large cell which forms the entire plant in a Vaucheria, a unicellular alga very common in shallow ditches, be ruptured under the microscope, its protoplasm

will escape, and may then be often seen to throw out pseudopodial projections, and exhibit amœboid movements.

Even in the higher plants, without adducing such obvious and well-known instances as those of the Sensitive Plant and Venus's Flytrap, the irritability of the protoplasm may be easily rendered manifest. There are many herbaceous plants in which if the young succulent stem of a vigourously-growing specimen receive a sharp blow, of such a nature, however, as not to bruise its tissues, or in any way wound it, the blow will sometimes be immediately followed by a drooping of the stem commencing at some distance above the point at which the stroke had been applied; its strength appears to have here suddenly left it; it is no longer able to bear its own weight, and seems to be dying. The protoplasm, however, of its cells, is in this instance not killed; it is only stunned by the violence of the blow, and needs time for its restoration. After remaining, it may be for some hours, in this drooping and flaccid state, the stem begins to raise itself, and soon regains its original vigour. This experiment will generally succeed well in plants with a rather large terminal spike or raceme when the stroke is applied some little distance below the inflorescence shortly before the expansion of the flower.

In the several instances now adduced the protoplasm is in the mature state of the plant entirely included within a wall of cellulose. Some recent beautiful observations, however, of Mr. Francis Darwin have shown that even in the higher plants truly naked protoplasm may occur. From the cells of certain glandular hairs contained within the cup-like receptacles formed by the united basis of two opposite leaves in the Teazel (*Dipsacus*) he has seen emitted long pseudopodia-like projections of the protoplasm. What may be the significance of this very exceptional phenomenon is still undertermined. It is probably, as Mr. Darwin supposes, connected with the absorption of nitrogeneous matter.

That there is no essential difference between the protoplasm of plants and that of animals is rendered further evident by other motor phenomena, which we are in the habit of regarding as the exclusive attribute of animals. Many of the more simply organised plants give origin to peculiar cells called spores, which separate from the parent, and, like the seeds of the higher plants, are distined to repeat its form. In many cases these spores are eminently locomotive. They are then termed "swarm spores," and their movements are brought about, sometimes by changes of shape, when they move about in the manner of an *Amœba*, but more frequently by minute vibratile cilia, or by more strongly developed flagella or whip-like projections of their protoplasm. These cilia and flagella are absolutely indistinguishable from similar structures widely distributed among animals, and by their vibratory or lashing strokes upon the surrounding water the swarm-spores are rapidly carried from place to place. In these

motions they often present a curious semblance of volition, for if the swarm-spore meet with an obstacle in its course, it will, as if to avoid it, change the direction of its motion, and retreat by a reversion of the stroke of its cilia. They are usually attracted by light, and congregate at the light side of the vessel which contains them, though in some cases light has the opposite effect on them, and they recede from it.

Another fact may here be adduced to show the uniform character of protoplasm and how very different are its properties from those of lifeless matter, namely, the faculty which all living protoplasm possesses of resisting the entrance of colouring matter into its substance. As many here present are aware, microscopists are in the habit of using in their investigations various colouring matters, such as solutions of carmine. These act differently on the different tissues, staining some, for example, more deeply than others, and thus enabling the histologist to detect certain elements of structure, which would otherwise remain unknown. Now if a solution of carmine be brought into contact with living protoplasm, this will remain, so long as it continues alive, unaffected by the colouring matter. But if the protoplasm be killed, the carmine will at once pervade its whole substance, and stain it throughout with a colour more intense than even that of the colouring solution itself.

But no more illustrative example can be offered of the properties of protoplasm as living matter, independently of any part it may take in organization, than that presented by the Myxomycetæ.

The Myxomycetæ constitute a group of remarkable organisms, which, from their comparatively large size and their consisting, during a great part of their lives, of naked protoplasm, have afforded a fine field for research, and have become one of the chief sources from which our knowledge of the nature and phenomena of protoplasm has been derived.

They have generally been associated by botanists with the fungi, but though their affinities with these are perhaps closer than with any other plants, they differ from them in so many points especially in their development as to render this association untenable. They are found in moist situations, growing on old tan or moss, or decaying leaves or rotten wood, over which they spread in the form of a network of protoplasmic filaments, of a soft creamy consistence, and usually of a yellowish colour.

Under the microscope the filaments of the network exhibit active spontaneous movements, which, in the larger branches, are visible under an ordinary lens, or even by the naked eye. A succession of undulations may then be noticed passing along the course of the threads. Under higher magnifying powers a constant movement of granules may be seen flowing along the threads, and steaming from branch to branch of this wonderful network. Here and there offshoots of the protoplasm are projected,

and again withdrawn in the manner of the pseudopodia of an *Amœba*, while the whole organism may be occasionally seen to abandon the support over which it had grown, and to creep over neighbouring surfaces, thus far resembling in all respects a colossal ramified *Amœba*. It is curiously sensitive to light, and may be sometimes found to have retreated during the day to the dark side of the leaves, or into the recesses of the tan over which it had been growing, and began to creep out on the approach of night.

After a time there arise from the surface of this protoplasmic net oval capsules, or spore cases, in which are contained the spores, or reproductive bodies, of the Myxomycetæ. When the spore-case has arrived at maturity, it bursts, and allows the spores to escape. These are in the form of spherical cells, each included in a delicate membranous wall, and when they fall into water the wall becomes ruptured, and the little cell creeps out. This consists of a little mass of protaplasm with a round central nucleus, inclosing a nucleolus, and with a clear vacuole, which exhibits a rhythmically pulsating movement. The little naked spore thus set at liberty is soon seen to be drawn out at one point into a long vibratile whip-like flagellum, which by its lashing action carries the spore from place to place. After a time the flagellum disappears, and the spore may now be seen emitting and withdrawing finger-like pseudopodia, by means of which it creeps about like an *Amœba*, and, like an *Amœba*, devours solid particles by engulfing them in its soft protoplasm.

So far these young *Amœba*-like Myxomycetæ have enjoyed each an independent existence. Now, however, a singular and significant phenomenon is presented. Two or more of these Myxamœbæ, as they have been called, approach one another, come into contact, and finally become completely fused together into a single mass of protoplasm, in which the components are no longer to be distinguished. To the body which is thus formed by the fusion of the Myxamœbæ the name of "plasmodium" has been given.

The plasmodium continues, like the simple amœbiform bodies of which it is composed, to grow by the ingestion and assimilation of solid nutriment, which it envelopes in its substance; it throws out ramifying and mosculating processes, and finally becomes converted into a protoplasmic network, which in its turn gives rise to spore-cases with their contained spores, and thus completes the cycle of its development.

Under certain external conditions, the Myxomycetæ have been observed to pass from an active mobile state into a resting state, and this may occur both in the amœbiform spores and in the plasmodium. When the plasmodium is about to pass into a resting state it usually withdraws its finer branches, and expels such solid ingesta as may be included in it. Its motions then gradually cease, it breaks up into a multitude of polyhedral cells, which, however, remain connected, and the whole body dries into a horny

brittle mass, known by the name of "sclerotium."

In this condition, without giving the slightest sign of life, the sclerotium may remain for many months. Life, however, is not destroyed, its manifestations are only suspended, and if after an indefinite time the apparently dead sclerotium be placed in water, it immediately begins to swell up, the membranous covering of its component cells becomes dissolved and disappears, and the cells themselves flow together into an active amœboid plasmodium.

We have already seen that every cell possesses an autonomy or independent individuality, and from this we should expect that, like all living beings, it had the faculty of multiplying itself, and of becoming the parent of other cells. This is truly the case, and the process of cell-multiplication has of late years been studied, with the result of adding largely to our knowledge of the phenomena of life.

The labours of Strasburger, of Auerbach, of Oscar Hertwig, of Eduard van Beneden, Butschli, Fol, and others, here come prominently before us, but neither the time at my disposal nor the purport of this address will allow me to do more than call your attention to some of the more striking results of their investigations.

By far the most frequent mode of multiplication among cells shows itself in a spontaneous division of the protoplasm into two separate portions, which then become independent of one another, so that instead of the single parent cell two new ones have made their appearance. In this process the nucleus usually takes an important part. Strasburger has studied it with great care in certain plant cells, such as the so-called "corpuscula" or "secondary embryo-sacs" of the Coniferæ and the cells of Spirogyra; and has further shown a close correspondence between cell division in animals and that in plants.

It may be generally stated as the results of his observations on the corpuscula of the Coniferæ, that the nucleus of the cell about to divide assumes a spindle shape, and at the same time presents a peculiar striated differentiation, as if it were composed of parallel filaments reaching from end to end of the spindle. These filaments become thickened in the middle, and there form by the approximation of the thickened portions a transverse plate of protoplasm (the "nucleus-plate"). This soon splits into two halves, which recede from one another towards the poles of the spindle, travelling in this course along the filaments, which remain continuous from end to end. When arrived near the poles they form there two new nuclei, still connected with one another by the intervening portion of the spindle.

In the equator of this intervening portion there is now formed in a similar way a second plate of protoplasm (the "cell-plate"), which, extending to the walls of the dividing cell, cuts the whole protoplasm into two halves, each half containing one of the newly-formed nuclei. This partition plate is at first single, but it soon splits into two laminæ, which be

come the apposed bounding surfaces of the two protoplasm masses into which the mother cell has been divided. A wall of cellulose is then all at once secreted between them, and the two daughter cells are complete.

It sometimes happens in the generation of cells that a young brood of cells arises from the parent cell by what is called "free cell formation." In this only a part of the protoplasm of the mother cell is used up in the production of the offspring. It is seen chiefly in the formation of the spores of the lower plants, in the first foundation of the embryo in the higher, and in the formation of the endosperm—a cellular mass which serves as the first nutriment for the embryo—in the seeds of most Phanerogams. The formation of the endosperm has been carefully studied by Strasburger in the embryo-sac of the kidney bean, and may serve as an example of the process of free cell formation. The embryo-sac is morphologically a large cell with its protoplasm, nucleus, and cellulose wall, while the endosperm which arises within it is composed of a multitude of minute cells, united into a tissue. The formation of the endosperm is preceded by the dissolution and disappearance of the nucleus of the embryo-sac, and then in the midst of the protoplasm of the sac several new nuclei make their appearance. Around each of these as a centre the protoplasm of the mother cell is seen to have become differentiated in the form of a clear spherule, and we have thus corresponding to each of the new nuclei a young naked cell, which soon secretes over its surface a membrane of cellulose. The new cells, when once formed, multiply by division, press one on the other, and so combining into a cellular mass, constitute the completed endosperm.

Related to the formation of new cells, whether by division or by free cell formation, is another very interesting phenomenon of living protoplasm known as "rejuvenescence" In this the whole protoplasm of a cell, by a new arrangement of its parts, assumes a new shape and acquires new properties. It then abandons its cellulose chamber, and enters on a new and independent life in the surrounding medium.

A good example of this is afforded by the formation of swarm-spores in Œdogonium, one of the fresh-water algæ. Here the whole of the protoplasm of an adult cell contracts, and by the expulsion of its cell-sap changes from a cylindrical to a globular shape. Then one spot becomes clear, and a pencil of vibratile cilia here shows itself. The cellulose wall which had hitherto confined it now becomes ruptured, and the protoplasmic sphere, endowed with new faculties of development and with powers of active locomotion, escapes as a swarm-spore, which, after enjoying for a time the free life of an animal, comes to rest, and develops itself into a new plant.

The beautiful researches which have within the last few years been made by the observers already mentioned, on the division of animal cells, show how close is the agreement between plants and animals in all the leading phe-

nomena of cell division, and afford one more proof of the essential unity of the two great organic kingdoms.

There is one form of cell which, in its relation to the organic world, possesses a significance beyond that of every other, namely, the egg. As already stated, the egg is, wherever it occurs, a typical cell, consisting essentially of a globule of protoplasm enveloping a nucleus (the "germinal vesicle"), and with one or more nucleoli (the "germinal spots") in the interior of the nucleus. This cell, distinguishable by no tangible characters from thousands of other cells, is nevertheless destined to run through a definite series of developmental changes, which have as their end the building up of an organism like that to which the egg owes its origin.

It is obvious that such complex organisms as thus result—composed, it may be, of countless millions of cells—can be derived from the simple egg cell only by a process of cell multiplication. The birth of new cells derived from the primary cell or egg thus lies as the basis of embryonic development. It is here that the phenomena of cell multiplication in the animal kingdom can in general be most satisfactorily observed, and the greater number of recent researches into the nature of these phenomena have found their most fertile field in the early periods of the development of the egg.

A discussion of the still earlier changes which the egg undergoes in order to bring it into the condition in which cell multiplication may be possible, would, however full of interest, be here out of place; and I shall therefore confine myself to the first moments of actual development—to what is called "the cleavage of the egg"—which is nothing more than a multiplication of the egg cell by repeated division. I shall further confine myself to an account of this phenomenon as presented in typical cases, leaving out of consideration certain modifications which would only complicate and obscure our picture.

The egg, notwithstanding the preliminary changes to which I have alluded, is still at the commencement of development a true cell. It has its protoplasm and its nucleus, and it is, as a rule, enveloped in a delicate membrane. The protoplasm forms what is known as the vitellus, or yolk, and the surrounding membrane is called the "vitellary membrane." The division which is now about to take place in it is introduced by a change of form in the nucleus. This becomes elongated, and assumes the shape of a spindle, similar to what we have already seen in the cell-division of plants. On each pole of the spindle transparent protoplasm collects, forming here a clear spherical area.

At this time a very striking and characteristic phenomenon is witnessed in the egg. Each pole of the spindle has become the centre of a system of rays which stream out in all directions into the surrounding protoplasm. The protoplasm thus shows, enveloped in its mass, two sun-like figures, whose centres are connected to one another by the spindle-shaped nucleus. To this, with the sun-

like rays streaming from its poles, Auerbach gives the name of "Karyolitic figure," suggested by its connection with the breaking up of the original nucleus, to which our attention must next be directed.

A phenomenon similar to one we have already seen in cell-division among plants now shows itself. The nucleus becomes broken up into a number of filaments, which lie together in a bundle, each filament stretching from pole to pole of the spindle. Exactly in its central point every filament shows a knot-like enlargement, and from the close approximation of the knots there results a thick zone of protoplasm in the equator of the spindle. Each knot soon divides into two halves, and each half recedes from the equator and travels along the filament towards its extremity. When arrived at the poles of the spindle each set of half-knots becomes fused together into a globular body, while the intervening portion of the spindle, becoming torn up, and gradually drawn into the substance of the two globular masses, finally disappears. And now, instead of the single fusiform nucleus whose changes we have been tracing, we have two new globular nuclei, each occupying the place of one of its poles, and formed at its expense.[9] The egg now begins to divide along a plane at right angles to a line connecting the two nuclei. The division takes place without the formation of a cell-plate such as we saw in the division of the plant cell, and is introduced by a constriction of its protoplasm, which commences at the circumference just within the vitelline membrane, and extending towards the centre, divides the whole mass of protoplasm into two halves, each including within it one of the new nuclei. Thus the simple cell which constituted the condition of the egg at the commencement of development becomes divided into two similar cells. This forms the first stage of cleavage. Each of these two young cells divides in its turn in a direction at right angles to the first division-plane, while by continued repetition of the same act the whole of the protoplasm

[9] Though none of the above-mentioned observers to whom we owe our knowledge of the phenomena here described seem to have thought of connecting the fibrous condition assumed by the spindle with any special structure of the quiescent nucleus, it is highly probable that it consists in a rearrangement of fibres already present That this is really the case is borne out by the observations of Schleicher on the division of cartilage cells ("Die Knorpelzelltheilung," *Arch. fur mikr. Anat*, Band xvi Heft 2, 1878). From these it would appear that in the division of cartilage cells the investing membrane of the nucleus first becomes torn up, and then the filaments, rodlets, and granules, which, according to him, form its body, enter into a state of intense motor activity, and may be seen arranging themselves into star-like, or wreath-like, or irregular figures, while the whole nucleus, now deprived of its membrane, may wander about the cell, travelling towards one of its poles, and then towards the other; or it may at one time contract, and then again dilate, to such an extent as nearly to fill the entire cell To this nuclear activity Schleicher applies the term "Karyokinesis." It results in a nearly parallel arrangement of the nuclear filaments Then these converge at their extremities, and become more widely separated in the middle, so as to give to the nucleus the form of a spindle The filaments then become fused together at each pole of the spindle, so as to form the two new nuclei, which are at first nearly homogeneous, but which afterwards become broken up into their component filaments, rods, and granules.

or yolk becomes broken up into a vast multitude of cells, and the unicellular organism—the egg, with which we began our history—has become converted into an organism composed of many thousands of cells. This is one of the most widely distributed phenomena of the organic world. It is called "the cleavage of the egg," and consists essentially in the production, by division, of successive broods of cells from a single ancestral cell—the egg.

It is no part of my purpose to carry on the phenomena of development further than this. Such of my hearers as may desire to become acquainted with the further history of the embryo, I would refer to the excellent address delivered two years ago at the Plymouth meeting of the Association by one of my predecessors in this chair—Professor Allen Thompson.

That protoplasm, however, may present a phenomenon the reverse of that in which a simple cell becomes multiplied into many, is shown by a phenomenon already referred to—the production of plasmodia in the Myxomycetæ by the fusion into one another of cells originally distinct.

The genus *Myriothela* will afford another example in which the formation of plasmodia becomes introduced into the cycle of development. The primitive eggs are here, as elsewhere, true cells with nucleolated nuclei, but without any boundary membrane. They are formed in considerable numbers, but remain only for a short time separate and distinct. After this they begin to exhibit amœboid changes of shape, project pseudopodial prolongations which coalesce with those of others in their vicinity, and finally a multitude of these primitive ova become fused together into a common plasmodium, in which, as in the simple egg cell of other animals, the phenomena of development take place.

In many of the lower plants a very similar coalescence is known to take place between the protoplasmic bodies of separate cells, and constitutes the phenomenon of conjugation. *Spirogyra* is a genus of Algæ, consisting of long green threads common in ponds. Every thread is composed of a series of cylindrical chambers of transparent cellulose placed end to end, each containing a sac of protoplasm with a large quantity of cell sap, and with a green band of chlorophyll wound spirally on its walls. When the threads have attained their full growth they approach one another in pairs, and lie in close proximity, parallel one to the other. A communication is then established by means of short connecting tubes between the chambers of adjacent filaments, and across the channel thus formed the whole of the protoplasm of one of the conjugating chambers passes into the cavity of the other, and then immediately fuses with the protoplasm it finds there. The single mass thus formed shapes itself into a solid oval body, known as a "zygospore." This now frees itself from the filament, secretes over its naked surface a new wall of cellulose, and, when placed in the conditions necessary for its development, attaches itself by one end, and then, by repeated

acts of cell division, grows into a many-celled filament like those in which it originated.

The formation of plasmodia, regarded as a coalescence and absolute fusion into one another of separate naked masses of protoplasm, is a phenomenon of great significance. It is highly probable that, notwithstanding the complete loss of individuality in the combining elements, such differences as may have been present in these will always find itself expressed in the properties of the resulting plasmodia—a fact of great importance in its bearing on the phenomena of inheritance. Recent researches, indeed, render it almost certain that fertilisation, whether in the animal or the vegetable kingdom, consists essentially in the coalescence and consequent loss of individuality of the protoplasmic contents of two cells.

In by far the greater number of plants the protoplasm of most of the cells which are exposed to the sunlight undergoes a curious and important differentiation, part of it becoming separated from the remainder in the form usually of green granules, known as chlorophyll granules. The chlorophyll granules thus consist of true protoplasm, their colour being due to the presence of a green colouring matter, which may be extracted, leaving behind the colourless protoplasmic base.

The colouring matter of chlorophyll presents under the spectroscope a very characteristic spectrum. For our knowledge of its optical properties, on which time will not permit me to dwell, we are mainly indebted to the researches of your townsman, Dr. Sorby, who has made these the subject of a series of elaborate investigations, which have contributed largely to the advancement of an important department of physical science.

That the chlorophyll is a living substance, like the uncoloured protoplasm of the cell, is sufficiently obvious. When once formed, the chlorophyll granule may grow by intussusception of nutriment to many times its original size, and may multiply itself by division.

To the presence of chlorophyll is due one of the most striking aspects of external nature—the green colour of the vegetation which clothes the surface of the earth; and with its formation is introduced a function of fundamental importance in the economy of plants, for it is on the cells which contain this substance that devolves the faculty of decomposing carbonic acid. On this depends the assimilation of plants, a process which becomes manifest externally by the exhalation of oxygen. Now, it is under the influence of light on the chlorophyll-containing cells that this evolution of oxygen is brought about. The recent observations of Draper and of Pfeffer have shown that in this action the solar spectrum is not equally effective in all its parts; that the yellow and least refrangible rays are those which act with most intensity; that the violet and other highly refrangible rays of the visible spectrum take but a very subordinate part in assimilation; and that the invisible rays which lie beyond the violet are totally inoperative.

In almost every grain of chlorophyll one or more starch granules may be seen. This starch is chemically isometric with the cellulose cell wall, with woody fibre, and other hard parts of plants, and is one of the most important products of assimilation. When plants whose chlorophyll contains starch are left for a sufficient time in darkness, the starch is absorbed and completely disappears; but when they are restored to the light the starch reappears in the chlorophyll of the cells.

With this dependence of assimilation on the presence of chlorophyll a new physiological division of labour is introduced into the life of plants. In the higher plants, while the work of assimilation is allocated to the chlorophyll-containing cells, that of cell division and growth devolves on another set of cells, which, lying deeper in the plant, are removed from the direct action of light, and in which chlorophyll is therefore never produced. In certain lower plants, in consequence of their simplicity of structure and the fact that all the cells are equally exposed to the influence of light, this physiological division of labour shows itself in a somewhat different fashion. Thus in some of the simple green algæ, such as *Spirogyra* and *Hydrodictyon*, assimilation takes place as in other cases during the day, while their cell division and growth takes place chiefly, if not exclusively, at night. Strasburger, in his remarkable observations on cell divisions in *Spirogyra*, was obliged to adopt an artificial device in order to compel the *Spirogyra* to postpone the division of its cells to the morning.

Here the functions of assimilation and growth devolve on one and the same cell, but while one of these functions is exercised only during the day, the time for the other is the night. It seems impossible for the same cell at the same time to exercise both functions, and these are here accordingly divided between different periods of the twenty-four hours.

The action of chlorophyll in bringing about the decomposition of carbonic acid is not, as was recently believed, absolutely confined to plants. In some of the lower animals, such as *Stentor* and other infusoria, the Green Hydra, and certain green planariæ and other worms, chlorophyll is differentiated in their protoplasm, and probably always acts here under the influence of light exactly as in plants.

Indeed it has been proved[10] by some recent researches of Mr. Geddes, that the green planarias when placed in water and exposed to the sunlight give out bubbles of gas which contain from 44 to 55 per cent. of oxygen. Mr. Geddes has further shown that these animals contain granules of starch in their tissues, and in this fact we have another striking point of resemblance between them and plants.

A similar approximation of the two organic kingdoms has been shown by the beautiful research, of Mr. Darwin—confirmed and extended by his son, Mr. Francis

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10 "Sur la Fonction de la Chlorophyl- dans les Planaires vertes," *Comptes Rendus*, December, 1878.

Darwin—on Drosera and other so-called carnivorous plants. These researches, as is now well known, have shown that in all carnivorous plants there is a mechanism fitted for the capture of living prey, and that the animal matter of the prey is absorbed by the plant after having been digested by a secretion which acts like the gastric juice of animals.

Again, Nageli has recently shown[11] that the cell of the yeast fungus contains about 2 per cent. of peptine, a substance hitherto known only as a product of the digestion of azotised matter by animals.

Indeed, all recent research has been bringing out in a more decisive manner the fact that there is no dualism in life—that the life of the animal and the life of the plant are, like their protoplasm, in all essential points identical.

But there is, perhaps, nothing which shows more strikingly the identity of the protoplasm in plants and animals, and the absence of any deep-pervading difference between the life of the animal and that of the plant, than the fact that plants may be placed, just like animals, under the influence of anæsthetics.

When the vapour of chloroform or of ether is inhaled by the human subject, it passes into the lungs, where it is absorbed by the blood, and thence carried by the circulation to all the tissues of the body. The first to be affected by it is the delicate nervous element of the brain, and loss of consciousness is the result. If the action of the anæsthetic be continued, all the other tissues are in their turn attacked by it and their irritability arrested. A set of phenomena entirely parallel to these may be presented by plants.

We own to Claude Bernard a series of interesting and most instructive experiments on the action of ether and chloroform on plants. He exposed to the vapour of ether a healthy and vigorous sensitive-plant, by confining it under a bell-glass into which he introduced a sponge filled with ether. At the end of half an hour the plant was in a state of anæsthesia, all its leaflets remained fully extended, but they showed no tendency to shrink when touched. It was then withdrawn from the influence of the ether, when it gradually recovered its irritability, and finally responded, as before, to the touch.

It is obvious that the irritability of the protoplasm was here arrested by the anæsthetic, so that the plant became unable to give a response to the action of an external stimulus.

It is not, however the irritability of the protoplasm of only the motor elements of plants that anæsthetics are capable of arresting. These may act also on the protoplasm of those cells whose function lies in chemical synthesis, such as is manifested in the phenomena of the germination of the seed and in nutrition generally, and Claude Bernard has shown that germination is suspended by the action of ether or chloroform.

Seeds of cress, a plant whose

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11 "Ueber die chemische Zusammensetzung der Hefe," *Sitzungsbericht der math phys. Classe der k.k. Akad der Wissens. zu München*, 1878.

germination is very rapid, were placed in conditions favourable to a speedy germination, and while thus placed were exposed to the vapour of ether. The germination, which would otherwise have shown itself by the next day, was arrested. For five or six days the seeds were kept under the influence of the ether, and showed during this time no disposition to germinate. They were not killed, however, they only slept, for on the substitution of common air for the etherised air with which they had been surrounded, germination at once set in and proceeded with activity.

Experiments were also made on that function of plants by which they absorb carbonic acid and exhale oxygen, and which, as we have already seen, is carried on through the agency of the green protoplasm, or chlorophyll, under the influence of light—a function which is commonly, but erroneously, called the respiration of plants.

Aquatic plants afford the most convenient subjects for such experiments. If one of these be placed in a jar of water holding ether or chloroform in solution, and a bell-glass be placed over the submerged plant, we shall find that the plant no longer absorbs carbonic acid or emits oxygen. It remains, however, quite green and healthy. In order to awaken the plant, it is only necessary to place it in non-etherised water, when it will begin once more to absorb carbonic acid, and exhale ozygen under the influence of sunlight.

The same great phsiologist has also investigated the action of anæsthetics on fermentation. It is well known that alcoholic fermentation is due to the presence of a minute fungus, the yeast fungus, the living protoplasm of whose cells has the property of separating solutions of sugar into alcohol, which remains in the liquid, and carbonic acid, which escapes into the air.

Now, if the yeast plant be placed along with sugar in etherised water it will no longer act as a ferment. It is anæsthesiated, and cannot respond to the stimulus which, under ordinary circumstances, it would find in the presence of the sugar. If, now, it be placed on a filter, and the ether washed completely away, it will, on restoration to a saccharine liquid, soon resume its duty of separating the sugar into alcohol and carbonic acid.

Claude Bernard has further called attention to a very significant fact which is observable in this experiment. While the proper alcoholic fermentation is entirely arrested by the etherisation of the yeast plant, there still goes on in the saccharine solution a curious chemical change, the cane sugar of the solution being converted into grape sugar, a substance identical in its chemical composition with the cane sugar, but different in its molecular constitution. Now, it is well known from the researches of Berthollet, that this conversion of cane sugar into grape sugar is due to a peculiar inversive ferment, which, while it accompanies the living yeast plant, is itself soluble and destitute of life. Indeed it has been shown that in its natural conditions the yeast fungus is

unable of itself to assimilate cane sugar, and that in order that this may be brought into a state fitted for the nutrition of the fungus, it must be first digested and converted into grape sugar, exactly as happens in our own digestive organs. To quote Claude Bernard's graphic account.—

"The fungus ferment has thus beside it in the same yeast a sort of servant given by nature to effect this digestion. The servant is the unorganised inversive ferment. This ferment is soluble, and as it is not a plant, but an unorganised body destitute of sensibility, it has not gone to sleep under the action of the ether, and thus continues to fulfil its task."

In the experiment already recorded, on the germination of seeds, the interest is by no means confined to that which attaches itself to the arrest of the organising functions of the seed, those namely which manifest themselves in the development of the radicle and plumule and other organs of the young plant. Another phenomenon of great significance becomes at the same time apparent—the anæsthetic exerts no action on the concomitant chemical phenomena which in germinating seeds show themselves in the transformation of starch into sugar under the influence of diastase (a soluble and non-living ferment which also exists in the seed, and in the absorption of oxygen with the exhalation of carbonic acid. These go on as usual, the anæsthesiated seed continuing to respire, as proved by the accumulation of carbonic acid in the surrounding air. The presence of the carbonic acid was rendered evident by placing in the same vessel with the seeds which were the object of the experiment, a solution of barytes, when the carbonate became precipitated from the solution in quantity equal to that produced in a similar experiment with seeds germinating in unetherised air.

So, also in the experiment which proves the faculty possessed by the chlorophyllian cells of absorbing carbonic acid and exhaling oxygen under the influence of light may be arrested by anæsthetics, it could be seen that the plant, while in a state of anæsthesia, continued to respire in the manner of animals; that is, it continued to absorb oxygen and exhale carbonic acid. This is the true respiratory function which was previously masked by the predominant function of assimilation, which devolves on the green cells of plants, and which manifests itself under the influence of light in the absorption of carbonic acid and the exhalation of oxygen.

It must not, however, be supposed that the respiration of plants is entirely independent of life. The conditions which bring the oxygen of the air and the combustible matter of the respiring plant into such relations as may allow them to act on one another are still under its control, and we must conclude that in Claude Bernard's experiment the anæsthesia had not been carried so far as to arrest such properties of the living tissues as are needed for this.

The quite recent researches of

Schützenberger, who has investigated the process of respiration as it takes place in the cell of the yeast fungus, have shown that vitality is a factor in this process. He has shown that fresh yeast, placed in water, breathes like an aquatic animal, disengaging carbonic acid, and causing the oxygen contained in the water to disappear. That this phenomenon is a function of the living cell is proved by the fact that, if the yeast be first heated to 60° C. and then placed in the oxygenated water, the quantity of oxygen in the water remains unchanged; in other words, the yeast ceases to breathe.

Schützenberger has further shown that light exerts no influence on the respiration of the yeast cell—that the absorption of oxygen by the cell takes place in the dark exactly as in sunlight. On the other hand, the influence of temperature is well marked. Respiration is almost entirely arrested at temperatures below 10° C., it reaches its maximum at about 40° C., while at 60° C. it again ceases.

All this proves that the respiration of living beings is identical, whether manifested in the plant or in the animal. It is essentially a destructive phenomenon—as much so as the burning of a piece of charcoal in the open air, and, like it, is characterised by the disappearance of oxygen and the formation of carbonic acid.

One of the most valuable results of the recent careful application of the experimental method of research to the life phenomena of plants is thus the complete demolition of the supposed antagonism between respiration in plants and that in animals.

I have thus endeavoured to give you, in a few broad outlines, a sketch of the nature and properties of one special modification of matter, which will yield to none other in the interest which attaches to its study, and in the importance of the part allocated to it in the economy of nature. Did the occasion permit I might have entered into many details which I have left untouched; but enough has been said to convince you that in protoplasm we find the only form of matter in which life can manifest itself; and that, though the outer conditions of life—heat, air, water, food—may all be present, protoplasm would still be needed, in order that these conditions may be utilised—in order that the energy of lifeless nature may be converted into that of the countless multitudes of animal and vegetable forms which dwell upon the surface of the earth or people the great depths of its seas.

We are thus led to the conception of an essential unity in the two great kingdoms of organic nature—a structural unity, in the fact that every living being has protoplasm as the essential matter of every living element of its structure; and a physiological unity, in the universal attribute of irritability, which has its seat in this same protoplasm, and is the prime mover of every phenomenon of life.

We have seen how little mere form has to do with the essential properties of protoplasm. This may shape itself into cells, and the cells may combine into organs

in ever-increasing complexity, and protoplasm force may be thus intensified, and, by the mechanism of organization, turned to the best possible account; but we must still go back to protoplasm as a naked, formless plasma if we would find — freed from all non-essential complications—the agent to which has been assigned the duty of building up structure and of transforming the energy of lifeless matter into that of living.

To suppose, however, that all protoplasm is identical where no difference cognisable by any means at our disposal can be detected would be an error. Of two particles of protoplasm, between which we may defy all the power of the microscope, all the resources of the laboratory, to detect a difference, one can develop only to a jelly-fish, the other only to a man, and one conclusion alone is here possible—that deep within them there must be a fundamental difference which thus determines their inevitable destiny; but of which we know nothing, and can assert nothing beyond the statement that it must depend on their hidden molecular constitution.

In the molecular condition of protoplasm there is probably as much complexity as in the disposition of organs in the most highly differentiated organisms; and between two masses of protoplasm indistinguishable from one another there may be as much molecular difference as there is between the form and arrangement of organs in the most widely separated animals or plants.

Herein lies the many-sidedness of protoplasm; herein lies its significance as the basis of all morphological expression, as the agent of all physiological work, while in all this there must be an adaptiveness to purpose as great as any claimed for the most complicated organism.

From the facts which have been now brought to your notice there is but one legitimate conclusion — that life is a property of protoplasm. In this assertion there is nothing that need startle us. The essential phenomena of living beings are not so widely separated from the phenomena of lifeless matter as to render it impossible to recognise an analogy between them; for even irritability, the one grand character of all living beings, is not more difficult to be conceived of as a property of matter than the physical phenomena of radial energy.

It is quite true that between lifeless and living matter there is a vast difference—a difference greater far than any which can be found between the most diverse manifestations of lifeless matter. Though the refined synthesis of modern chemistry may have succeeded in forming a few principles which until lately had been deemed the proper product of vitality, the fact still remains that no one has ever yet built up one particle of living matter out of lifeless elements —that every living creature, from the simplest dweller on the confines of organisation up to the highest and most complex organism, has its origin in pre-existent living matter—that the protoplasm of to-day is but the continuation of the protoplasm of other ages, handed down to us

through periods of indefinable and indeterminable time.

Yet with all this, vast as the differences may be, there is nothing which precludes a comparison of the properties of living matter with those of lifeless.

When, however, we say that life is a property of protoplasm, we assert as much as we are justified in doing. Here we stand upon the boundary between life in its proper conception, as a group of phenomena having irritability as their common bond, and that other and higher group of phenomena which we designate as consciousness or thought, and which, however intimately connected with those of life, are yet essentially distinct from them.

When the heart of a recently-killed frog is separated from its body and touched with the point of a needle, it begins to beat under the excitation of the stimulus, and we believe ourselves justified in referring the contraction of the cardiac fibres to the irritability of their protoplasm as its proper cause. We see in it a remarkable phenomenon, but one nevertheless in which we can see unmistakable analogies with phenomena purely physical. There is no greater difficulty in conceiving of contractility as a property of protoplasm than there is of conceiving of attraction as a property of the magnet.

When a thought passes through the mind, it is associated, as we have now abundant reason for believing, with some change in the protoplasm of the cerebral cells. Are we, therefore, justified in regarding thought as a property of the protoplasm of these cells, in the sense in which we regard muscular contraction as a property of the protoplasm of muscle? or is it really a property residing in something far different, but which may yet need for its manifestation the activity of cerebral protoplasm?

If we could see any analogy between thought and any one of the admitted phenomena of matter, we should be justified in accepting the first of these conclusions as the simplest, and as affording a hypothesis most in accordance with the comprehensiveness of natural laws; but between thought and the physical phenomena of matter there is not only no analogy, but there is no conceivable analogy; and the obvious and continuous path which we have hitherto followed up in our reasonings from the phenomena of lifeless matter through those of living matter here comes suddenly to an end. The chasm between unconscious life and thought is deep and impassable, and no transitional phenomena can be found by which, as by a bridge, we may span it over; for even from irritability, to which, on a superficial view, consciousness may seem related, it is as absolutely distinct as it is from any of the ordinary phenomena of matter.

It has been argued that because physiological activity must be a property of every living cell, psychical activity must be equally so, and the language of the metaphysician has been carried into biology, and the "cell soul" spoken of as a conception inseparable from that of life.

That psychical phenomena

however, characterised as they essentially are by consciousness, are not necessarily co-extensive with those of life, there cannot be a doubt. How far back in the scale of life consciousness may exist we have as yet no means of determining, nor is it necessary for our argument that we should Certain it is that many things, to all appearance the result of volition are capable of being explained as absolutely unconscious acts; and when the swimming swarm-spore of an alga avoids collision, and, by a reversal of the stroke of its cilia, backs from an obstacle lying in its course, there is almost certainly in all this nothing but a purely unconscious act. It is but a case in which we find expressed the great law of the adaptation of living beings to the conditions which surround them. The irritability of the protoplasm of the ciliated spore responding to an external stimulus sets in motion a mechanism derived by inheritance from its ancestors, and whose parts are correlated to a common end—the preservation of the individual.

But even admitting that every living cell were a conscious and thinking being, are we therefore justified in asserting that its consciousness, like its irritability, is a property of the matter of which it is composed? The sole argument on which this view is made to rest is that from analogy. It is argued that because the life phenomena, which are invariably found in the cell, must be regarded as a property of the cell, the phenomena of consciousness by which they are accompanied must be also so regarded. The weak point in the argument is the absence of all analogy between the things compared, and as the conclusions rests solely on the argument from analogy, the two must fall to the ground together.

In a lecture[12] to which I once had the pleasure of listening—a lecture characterised no less by lucid exposition than by the fascinating form in which its facts were presented to the hearers, Professor Huxley argues that no difference, however great, between the phenomena of living matter and those of the lifeless elements of which this matter is composed should militate against our attributing to protoplasm the phenomena of life as properties essentially inherent in it; since we know that the result of a chemical combination of physical elements may exhibit physical properties totally different from those of the elements combined; the physical phenomena presented by water, for example, having no resemblance to those of its combining elements, oxygen and hydrogen.

I believe that Professor Huxley intended to apply this argument only to the phenomena of life in the stricter sense of the word. As such it is conclusive. But when it is pushed further, and extended to the phenomena of consciousness, it loses all its force. The analogy, perfectly valid in the former case, here fails. The properties of the chemical compound are like those of its components, still physical properties. They come within the wide cate-

[12] "The Physical Basis of Life" (see "Essays and Reviews," by T. H. Huxley).

gory of the universally accepted properties of matter, while those of consciousness belong to a category absolutely distinct—one which presents not a trace of a connection with any of those which physicists have agreed in assigning to matter as its proper characteristics. The argument thus breaks down, for its force depends on analogy alone, and here all analogy vanishes.

That consciousness is never manifested except in the presence of cerebral matter, or of something like it, there cannot be a question; but this is a very different thing from its being a property of such matter in the sense in which polarity is a property of the magnet, or irritability of protoplasm. The generation of the rays which lie invisible beyond the violet in the spectrum of the sun cannot be regarded as a property of the medium which by changing their refrangibility can alone render them apparent.

I know that there is a special charm in those broad generalisations which would refer many very different phenomena to a common source. But in this very charm there is undoubtedly a danger, and we must be all the more careful lest it should exert an influence in arresting the progress of truth, just as at an earlier period traditional beliefs exerted an authority from which the mind but slowly and with difficulty succeeded in emancipating itself.

But have we, it may be asked, made in all this one step forward towards an explanation of the phenomena of consciousness or the discovery of its source? Assuredly not. The power of conceiving of a substance different from that of matter is still beyond the limits of human intelligence, and the physical or objective conditions which are the concomitants of thought, are the only ones of which it is possible to know anything, and the only ones whose study is of value.

We are not, however, on that account forced to the conclusion that there is nothing in the universe but matter and force. The simplest physical law is absolutely inconceivable by the highest of the brutes, and no one would be justified in assuming that man had already attained the limit of his powers. Whatever may be that mysterious bond which connects organization with physical endowments, the one grand fact—a fact of inestimable importance—stands out clear and freed from all obscurity and doubt, that from the first dawn of intelligence there is with every advance in organization a corresponding advance in mind. Mind, as well as body, is thus travelling onwards through higher and still higher phases; the great law of evolution is shaping the destiny of our race; and though now we may at most but indicate some weak point in the generalization which would refer consciousness, as well as life, to a common material source, who can say that, in the far off future, there may not yet be evolved other and higher faculties from which light may stream in upon the darkness, and reveal to man the great mystery of Thought?

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